CSL CS-461 EPC Class 1 Gen 2 RFID Fixed Reader User's Manual

Version 1.4

CSL: The One-Stop-Shop for RFID Solutions

1 Content

2 FCC Statement

FCC NOTICE: To comply with FCC part 15 rules in the United States, the system must be professionally installed to ensure compliance with the Part 15 certification. It is the responsibility of the operator and professional installer to ensure that only certified systems are deployed in the United States. The use of the system in any other combination (such as co-located antennas transmitting the same information) is expressly forbidden.

3 Introduction

3.1 CS-461 EPC Class 1 Gen 2 Fixed Reader

CSL is a One-Stop-Shop for RFID equipment that operates in the UHF (800/900 MHz) band. The CSL CS-461 RFID Reader is a EPCglobal Class 1 Gen 2 certified fixed reader product. This reader is powered by Impinj technology, with extremely high inventory rate, tag velocity and true dense reader mode.

This reader can connect to and control four UHF antennas from its 4 TNC duplex antenna ports. In addition to the reader, CSL also offers a mono-static UHF antenna, CS-771, that is designed for CS-461 reader to utilize the power of this reader. Other accessories, such as RF cables, are also available from CSL.

Products	**Part Number**	**Photo**
EPC Class 1 Gen 2 Fixed Reader (4 Ports)	CS-461	
Antenna (Mono-static area or zonal antenna, long range)	CS-771	

Cable (Custom lengths available)	CS-801-1-2-N, N straight male connector on one side, TNC reverse male connector on the other side. (N is length of cable)	

3.2 How to Use this Manual

This manual provides a comprehensive introduction to the CSL CS-461 EPC Class1 Gen 2 RFID product (chapter 2), package information (chapter 3), hardware information (chapter 4), quick installation guide (chapter 5), detailed interfaces (chapter 6), RFID application guides (chapter 7) and the technical support information (chapter 8).

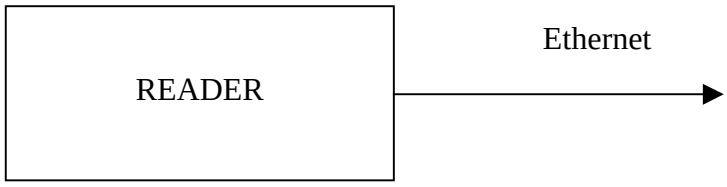
In addition to this user's manual, there are other programmer's manual for system integrators and software houses that develop their own software and would like to interface directly with this reader. Please refer to these manuals for the details of using the command sets.

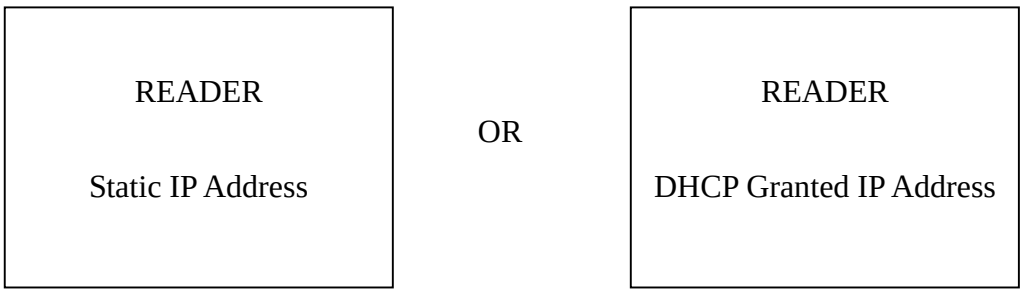
There are two ways of accessing the reader, high level access (HTTP-based) and low level access (TCP/IP socket based).

The High level access method is described in the CSL High Level API Manual, and the Low level access method is described in the CSL Low Level API Manual.

3.3 Connectivity Options

The CSL readers are connected to the network via Ethernet cable (RJ45 socket).
The reader can have a static IP address or can obtain an IP address using DHCP. Normally, a static IP address is more convenient to use because it does not change when the reader reboots, but the operator has to make sure there is no collision with other network devices in the network.



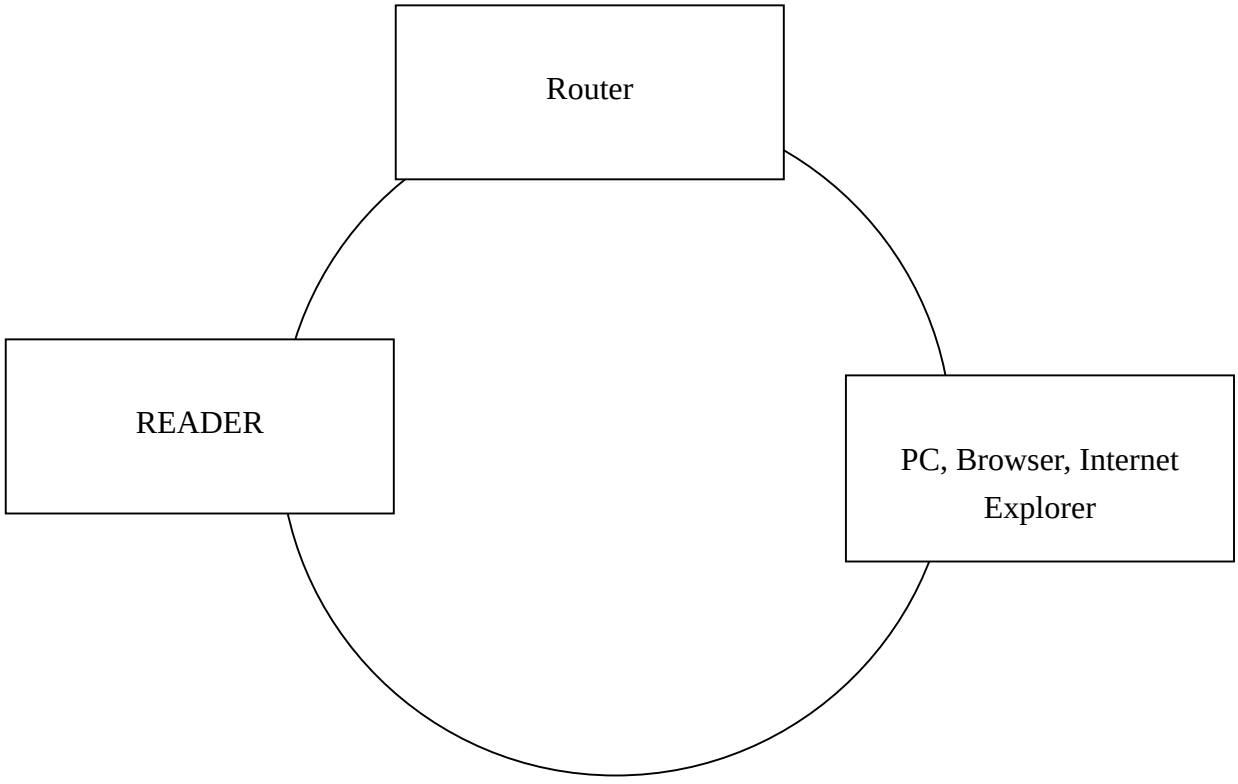


3.4 Browser Interface

The reader can be accessed from any PC via the Internet Explorer browser. The factory default setting of the reader is printed on the label of the reader. Just type in that IP address on the Internet Explorer and the web-based configuration interface of the reader will be shown.

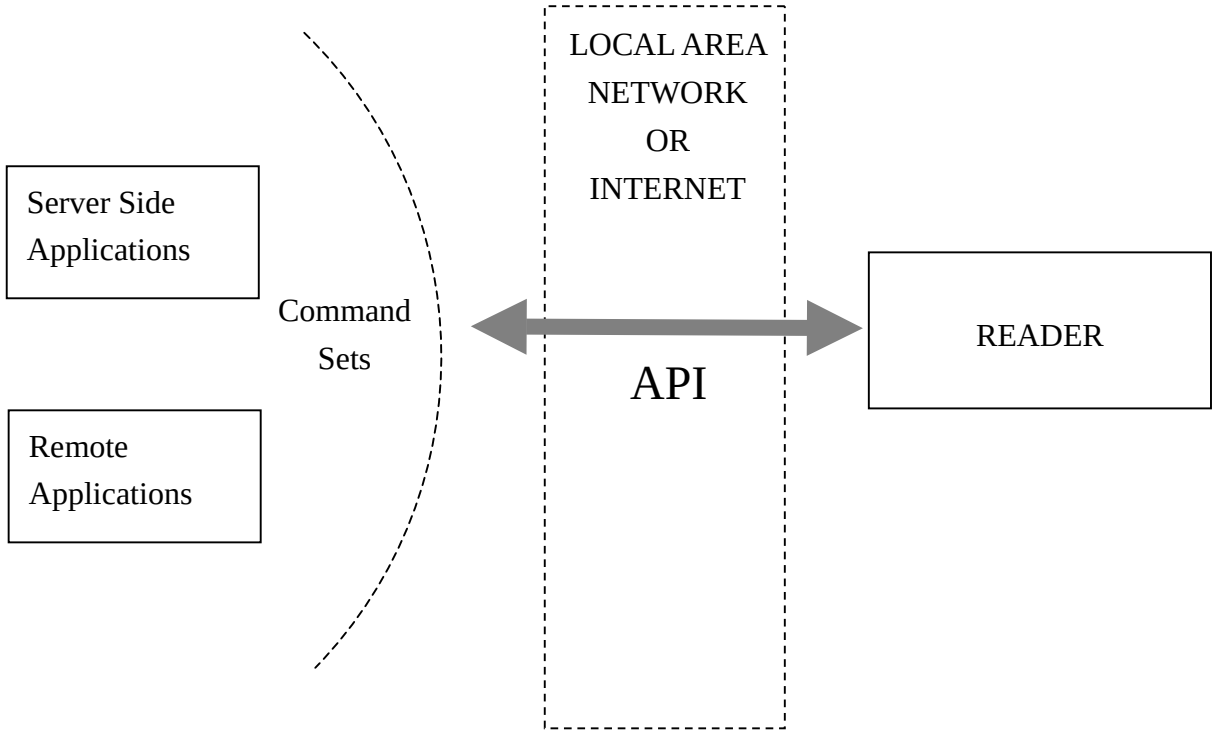
If you encounter any problem in accessing the browser interface, please make sure that the following software packages are properly installed on your PC:

- Microsoft .NET framework 2.0 or above



3.5 Programming Interfaces

The CSL CS-461 reader has a set of Application Programming Interfaces (API). Details of programming methods are described in the series of Command Set Manuals.



3.6 Advanced Features

The CS-461 RFID reader is an EPC Class 1 Gen 2 certified product. As powered by the advance and intelligent technology from Impinj, CS-461 has the unique feature of Dense Reader mode. It allows multiple readers to be used in very close separation or area without jamming each other. Thus, a wide range of applications can be powered by CS-461.

3.7 RFID Basic Principles

Passive tag RFID technology involves the reader, the antenna and the tag.

The reader sends out energy in the relevant frequency band to the antenna via RF cables, and the antenna radiates the energy out. This energy impinges on an RFID tag.

The RFID tag consists of an antenna coupled to an RFID IC. This IC converts the AC voltage it receives at the antenna port to DC voltage that in turn is used to empower the digital circuit inside.

The digital circuit then turns on and off some components connected to the antenna port, thereby changing its scattering behavior, in a pre-designed clock rate.

This changing of antenna port parameters then causes a “modulation” of the back-scattered RF energy.

This modulated back-scattered energy is detected by the reader and the modulation is captured and analyzed.

3.8 Product Specifications Briefs

3.8.1 CS-461

Features:

- Certified to the EPCglobal Class 1 Gen 2 UHF RFID protocol including dense reader mode
- Sophisticated data handling for efficient management of large streams of tag data on LAN resources
- Highly configurable buffering and tag filtering modes to eliminate the redundant tag data so as to reduce LAN traffic and server loading
- Compliant to the ISO 18000-6 type-C UHF RFID Standard
- 640 kbps tag-to-reader data rates
- Robust performance in dense-reader environments
- Excellent in transmit and receive mode – generates a different combination of unique reader-to-tag command rate, tag-to-reader backscatter rate, modulation format, and backscatter type
- Tremendous savings by using a single transmit/receive antenna for each of its four points ultra high inventory rate, read rate and tag velocity
- Settable and configurable parameters offer maximum throughput and optimal performance
- Supports all Gen 2 commands, including write, lock and kill

Specifications:

Physical Characteristics:	Length: 29.5 cm; Width: 30 cm; Height: 8 cm; Weight: 3 Kg
Mounting	Vertical orientation
Environment:	Operating Temp: -20^{0}C to 55^{0}C Storage Temp: -40^{0}C to 85^{0}C Humidity: 10% to 95% non-condensing Enclosure: IP-53
Antenna:	4 TNC duplex antenna ports, each single unit antenna for transmit and receive per port
Power:	Power adaptor for 110-240VAC auto-ranging to DC24Volts, 60Watt
RFID Frequency Ranges:	800 or 900 MHz band
Interfaces	10/100 BASE-T Ethernet RJ45 connector Configurable to use fixed IP address or DHCP RS-232 (DB9 connector) HTTP web server Tag air interface: EPC Class 1 Gen 2
Networking Protocols:	High Level: CSL High Level API Low Level: CSL Low Level API
Hardware Platform:	Xscale
Operating System:	Monta Vista Linux 3.1
Maximum Tag Read Rate:	1000 tag/sec.
Maximum Speed of Tag:	660 ft/min
Accessories:	Power cord
Order Code:	CS-461-P (P=1: 865-869MHz; P=2: 902-929MHz; P=3: 950-956MHz)
Restrictions on Use:	Approvals, features and parameters may vary depending on country legislation and may change without notice

4 Product Package

4.1 Basic Package Content

The reader package contains:

1 Reader
2 User Manual (in CD format)
3 Power Adapter
4 Power Cord
5 Plastic Cover

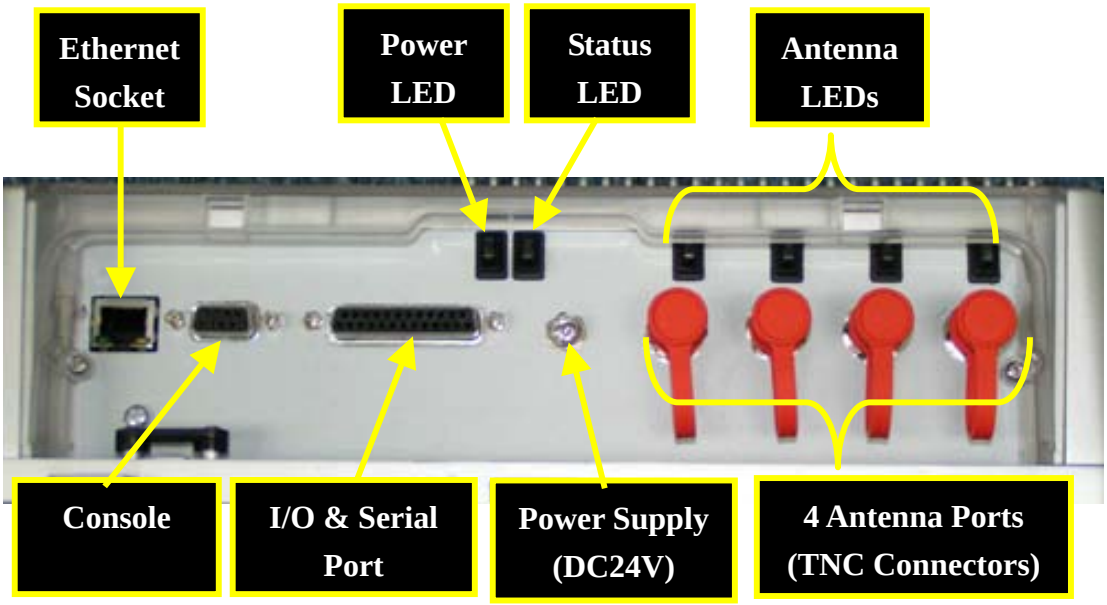
4.2 Unpacking Instructions

Unpacking of the reader is very simple. The only caution is that the RF connector sockets should be handled with care. The TNC reverse RF connectors come covered with plastic cap. They should remain covered when not in use to reduce chance of ESD entering the ports via the center conductors.

5 Hardware

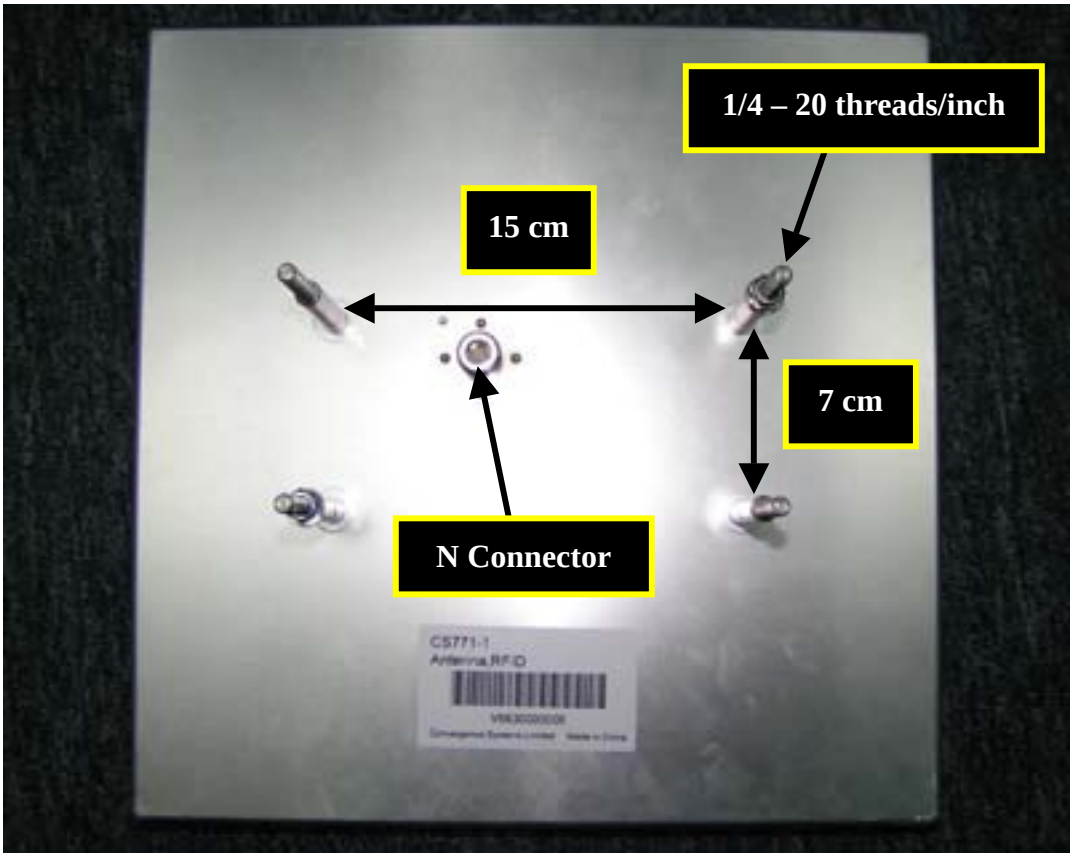
5.1 Basic Hardware Information

5.1.1 Reader Cable Connection



Note: Minimum cable length is 1.5m for this reader.

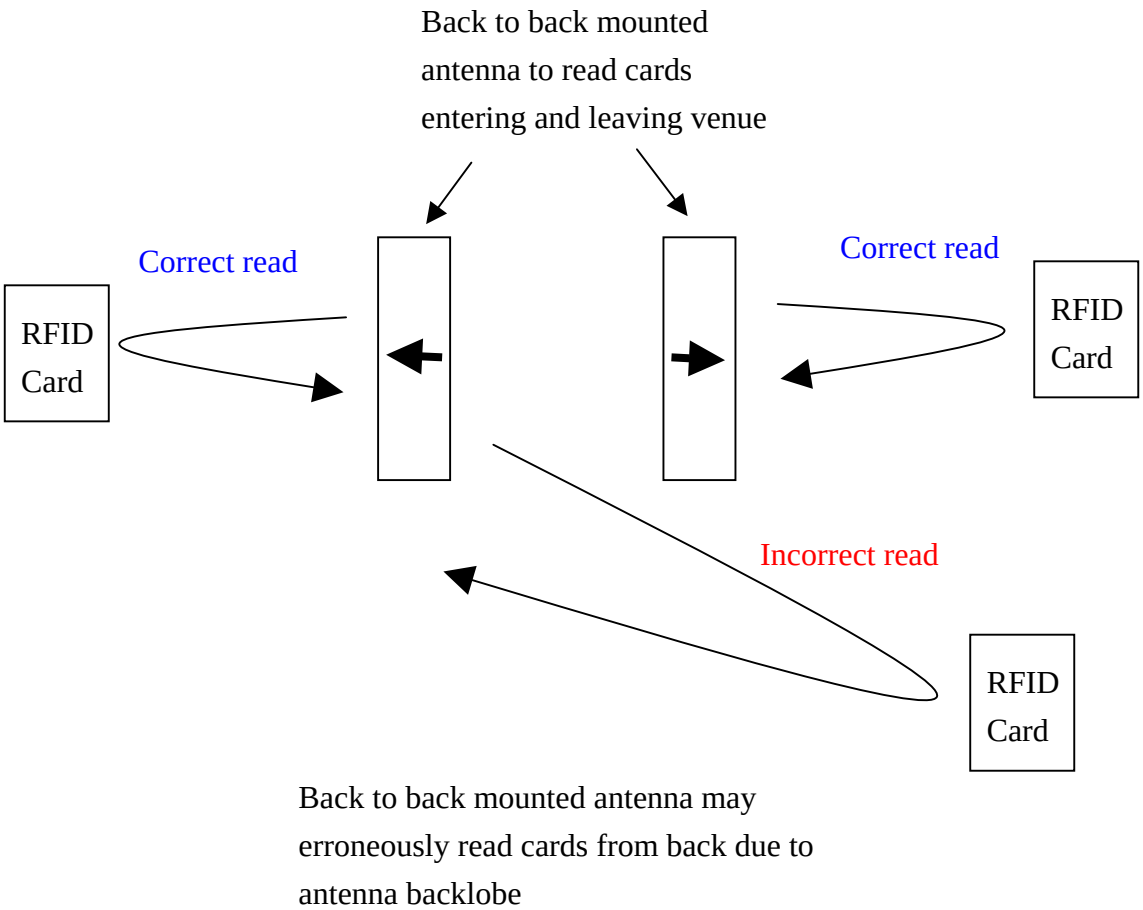
5.1.2 Antenna Cable Connection



CS-771 Mono-Static Antenna

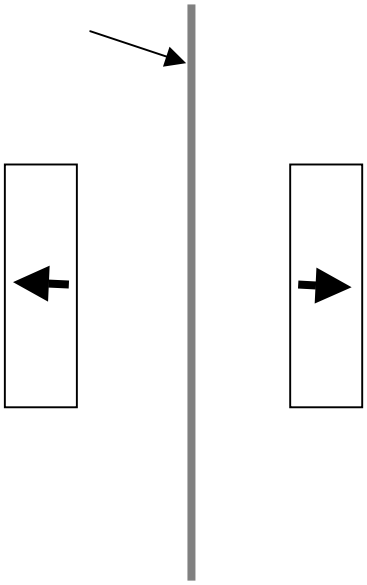
5.1.3 Antenna Installation

In antenna installation, especially when the reader is connected to multiple antennas, then the most important and immediate concern is spatial coupling between antenna, or, in other words, the isolation between antennas. If you mount antenna back to back, it is possible that the backlobe of the antenna will be able to transmit enough of the energy to turn on a tag that are on the opposite side and should have only been picked up by the antenna on that opposite side.

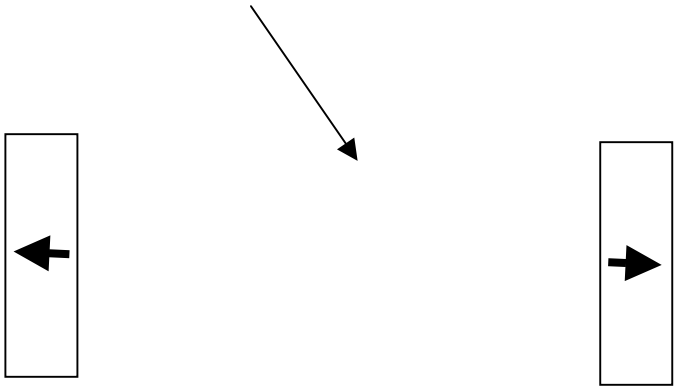


To prevent this erroneous read from happening, one can put spacer metal plate between the two back to back mounted antenna, or place the antenna farther apart, or a combination of the two methods:

Metal plate in between to isolate the two antennas, each dimension should be at least three times that of antenna



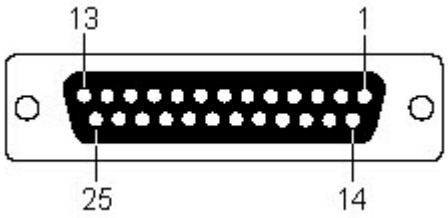
Increase the separation between the two antennas will increase the isolation between them.



Note also that the isolation between the different ports on the readers are not all the same. There are pairs with better isolation than others. Port 1 has best isolation with port 3, port 2 has best isolation with port 4. If isolation between antennas is found to be a problem, put the problem antennas at these best isolated pairs, i.e. connect one to port 1 and the other to port 3, or connect one to port 2 and the other to port 4.

5.1.4 IO Connection

The IO connector consists of one DB25 connector. The IO pins are using 3.3V TTL signal (i.e., 0V for logic 0 and 3.3V for logic 1). Since the current output from the port is low, users are recommended to connect minimal external circuitry for driving external device. The following are the pin-out definition:



Pin	Function	Pin	Function
1	Not connect	14	Data output 0
2	RXD input, RS232	15	Data output 1
3	TXD output, RS232	16	Data output 2
4	CTS input, RS232	17	Data output 3
5	RTS output, RS232	18	Data output 4
6	Not connect	19	Data output 5
7	Ground	20	Not connect
8	Not connect	21	Data output 6
9	Not connect	22	Not connect
10	Data input 3	23	Data output 7
11	Data input 2	24	Not connect
12	Data input 1	25	Not connect
13	Data input 0		

5.2 Cautions

Since the reader comes out of factory with a default static IP setting, the installer needs to set a PC to that subnet in order to go in to the reader and change the IP address to whatever he wants.

6 Quick Installation Guide

6.1 Hardware Installation

The reader can be setup easily as described below:

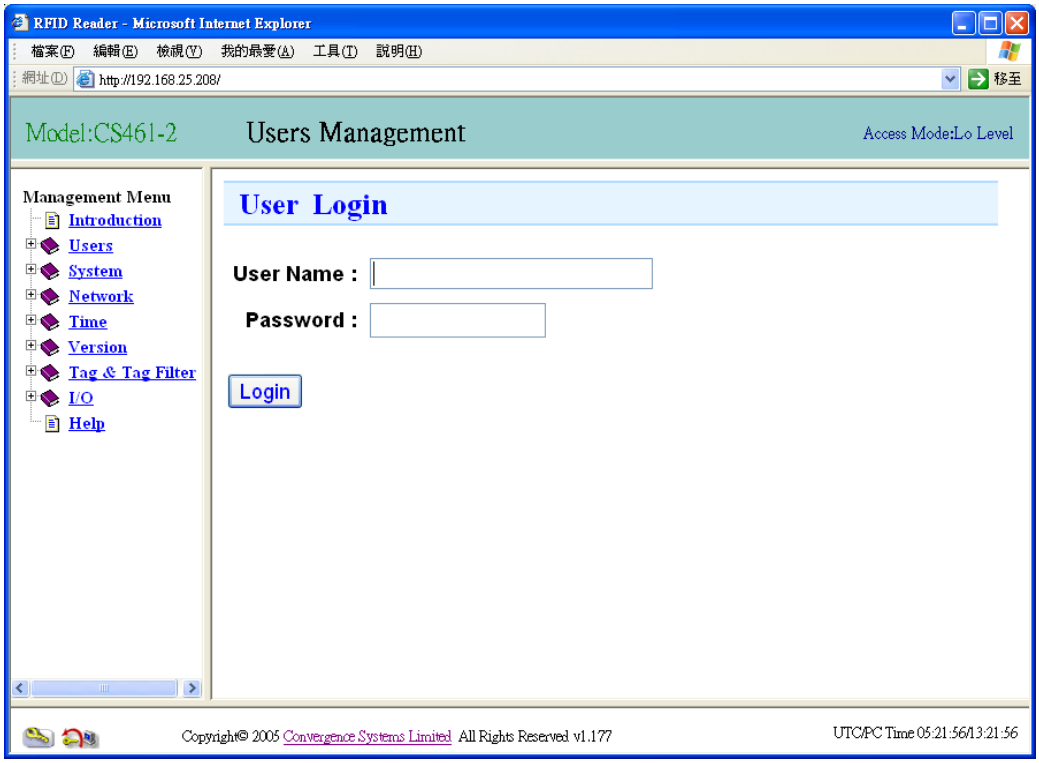
1. Connect the antenna(s) to the reader using the appropriate antenna cables (TNC reverse male connector to the reader side and N straight male connector to the antenna side).

2. Connect the reader to your network or computer using LAN cable on the LAN port. Please remember to use cross-over cable if it is direct reader-to-computer connection.

3. Plug in the power cord to the reader and switch on the power supply. Then the reader will boot up automatically. After the LEDs on the reader finished flashing and the Power LED remains in ON state, the reader has been boot up successfully. You can now use the web-based administration page of the reader to configure the reader.

4. In order to access the web-based administration interface of the reader, open a web browser (Internet Explorer) on your PC and enter the IP address of the reader on the URL field (the default IP address of the reader is printed on the label of the reader). Make sure that the PC is configured in the same subnet as the reader and they are properly connected on the LAN. Moreover, please set the option “Check for newer versions of stored page” to “Every visit to the page” on the IE. The steps for setting it is:
   - Select “Tools” pull-down menu of the IE
   - Select “Internet Option” dialog box
   - Select “General” section and click the “Settings” button inside “Temporary Internet Files”
   - Under “Check for newer versions of stored pages”, select “Every vsit to the page”.
   - Click “OK” twice to confirm the setting

5. After that, the web-based administration page of the reader will be displayed on the web browser as follows:



You can now login the configuration tool. The default administrator login name and password are as follows:

Login: root

Password: csl2006

Please refer to next chapter for the details of this configuration interface.

6. In addition to the web interface, a “Reader Demo Program” is also provided for your configuration and testing of the reader. Please refer to chapter 6 for the details.

6.2 Verification & Validation

The reader should be verified to be functioning properly:

1. Hook up all four ports to four antennae.

2. Set up the reader to read all four ports alternately (time division).

3. Take the sample tags and read them from the four antennae. Make sure there is not any other reader operating nearby.

4. Take the read range of the tags and check them against the standard performance.

7 Interface Details

This chapter describes the details of interface to the reader via three methods:

1. **Web Browser Interface**, interacting with the user via a web page using a web browser on a PC that is network connected to the reader. This is particularly useful for operators when configuring the reader. This interface operates when the reader is set as “High-level HTTP API Mode” in Access Mode.

2. **CSL Reader Demo Program**, interacting with the user via a Windows-based program on a PC that is network connected to the reader. This program can be used for controlling one or two readers simultaneously. It can help system integrators to test a single reader or two readers operating in dense reader mode quickly. This interface is particularly useful for site evaluation and installation. This interface can operate to control the reader when the reader is set as “Low-level Mach1 API Mode” in Access Mode.

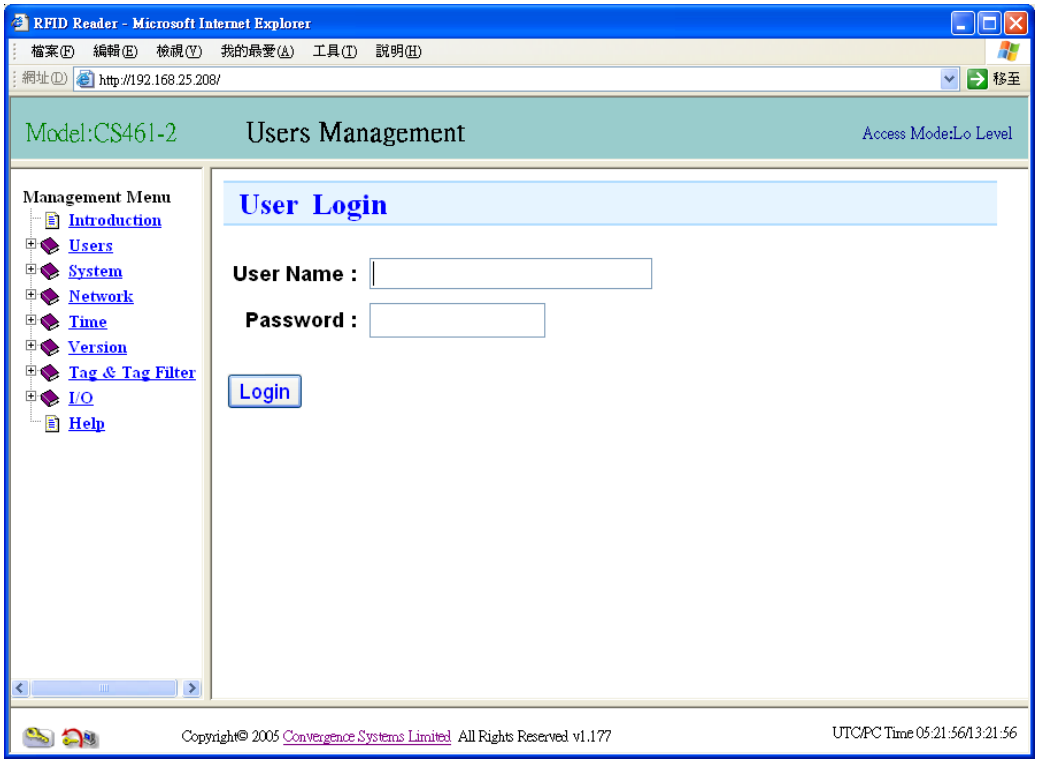
3. **Programming Interface**, interacting with the user’s program via an API library. This interface is particularly useful for connection to software resident on backend servers, such as ERP, SCM, and HR modules. It is fast – of course only up to the speed and latency of a LAN or Internet network. There are two APIs:
    i) the CSL High Level API, when the reader is set to “High-level HTTP API Mode” in Access Mode;
    ii) the CSL Low Level API, when the reader is set to “Low-level API Mode” in Access Mode.

7.1 Web Browser Interface

7.1.1 Home Page

The home page of the web-based administration interface can be entered by just entering the IP address of the reader (default IP address is printed on the label) on the web browser (Internet Explorer is required).
For example, if the IP address of the reader is 192.168.25.173, you should enter:
http://192.168.25.173

The firmware versions described in this manual are:
Edge Server: v1.177
Middleware: v1.124



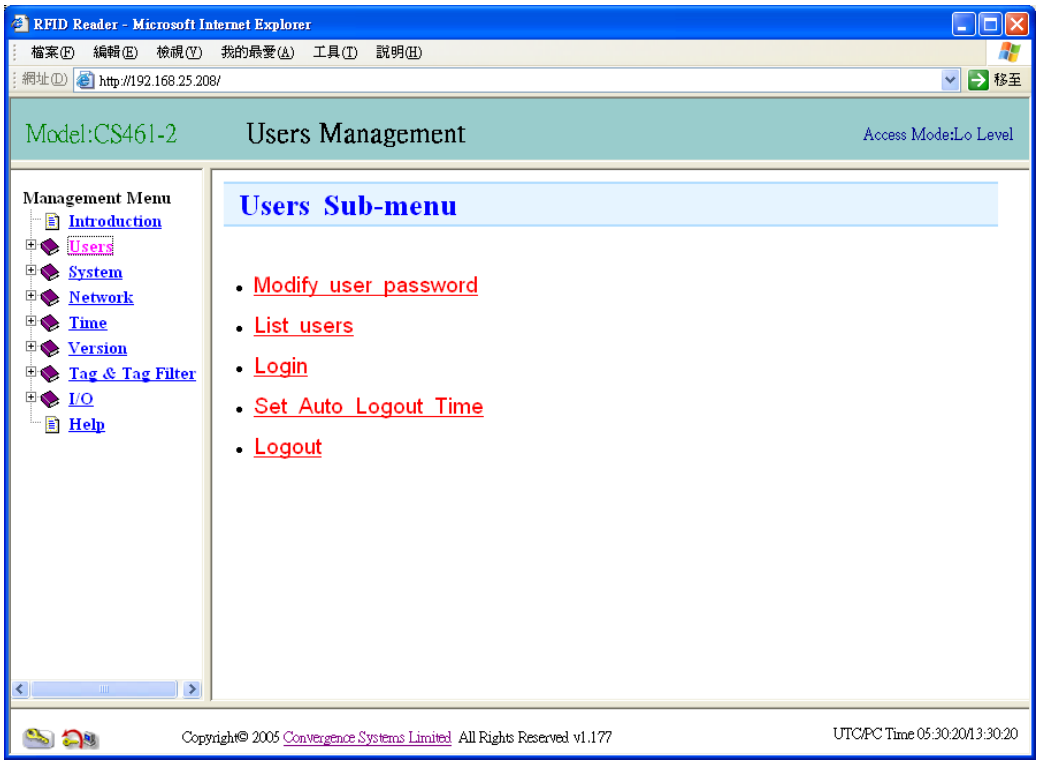
Special Caution:

- If you see a blank page after entering the web interface, please install the Microsoft XML Core Services (MSXML 4.0 Service Pack 2) and try again. It can be downloaded from the Microsoft Download Center web site.
- Please set the Internet Explorer "Check for newer versions of stored page"

option to "Every visit to the page". To do that, On your browser, from the menu bar "Tools" pull down menu, select "Internet Options". The "Internet Option" dialog box will come out, select the "General" section, look in the "Temporary Internet Files" sub-section and click the "Settings" button. A dialog box will come out. In this dialog box, under "Check for newer versions of stored pages", select "Every visit to the page". Click OK twice. This will take you out of the Internet Options configuration screen.

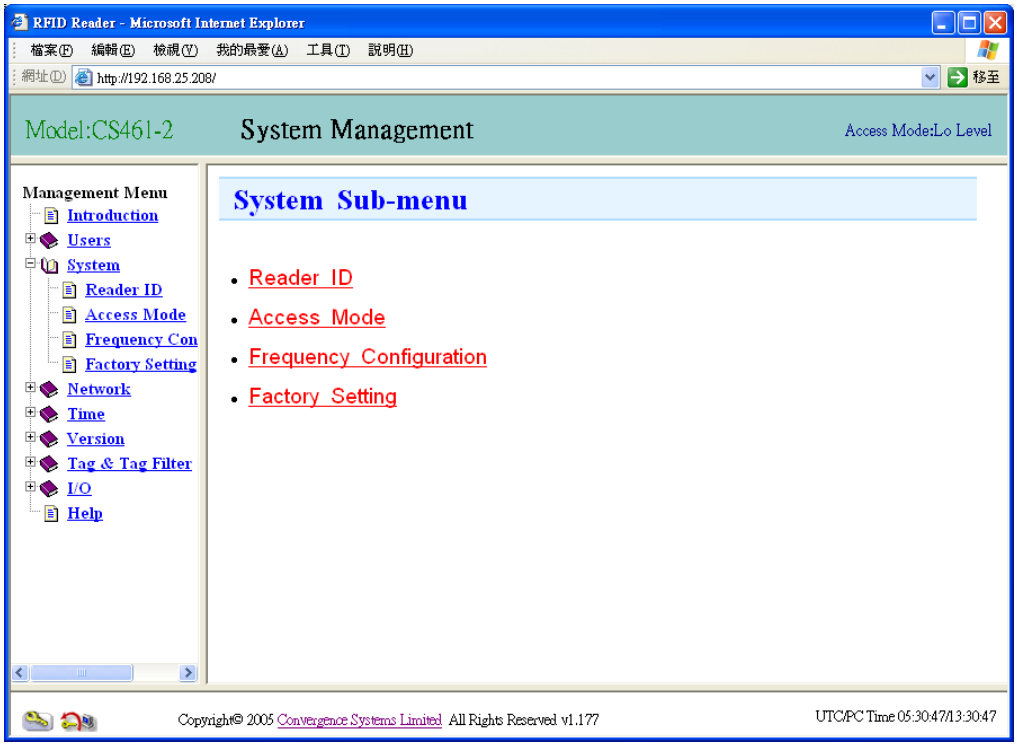
7.1.2 Users Management

The users management page contains sub-menu for modifying password, set auto-logout time and login/logout.

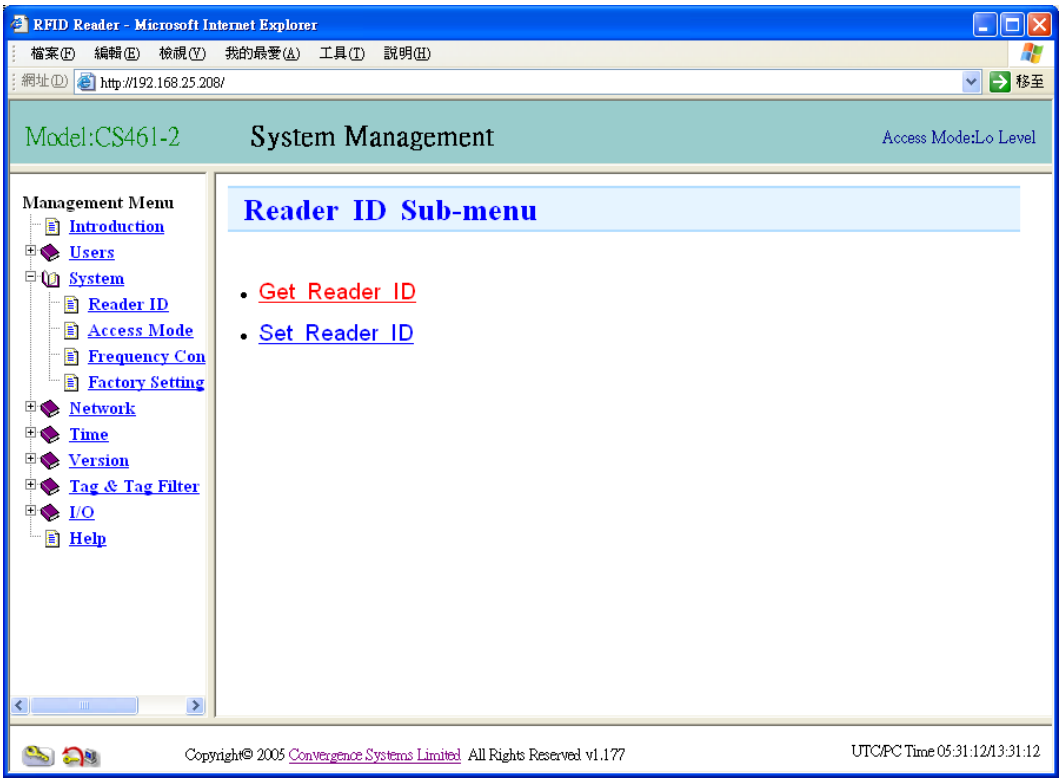


7.1.3 System Management

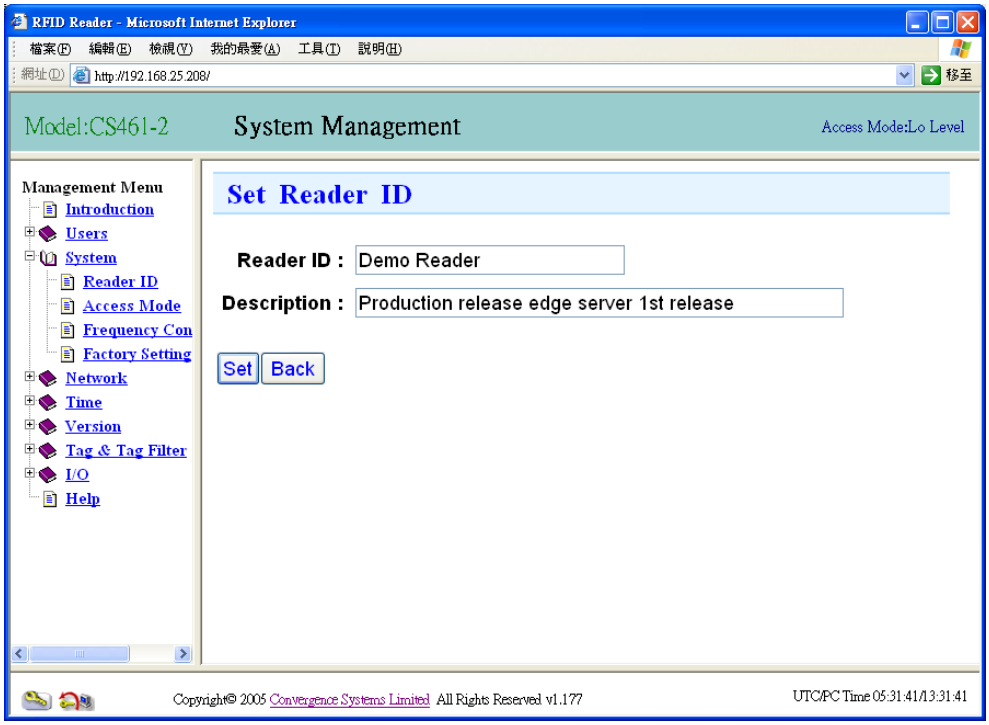
The system management page contains sub-menus to set reader ID and Access mode.



Here is the reader ID submenu:

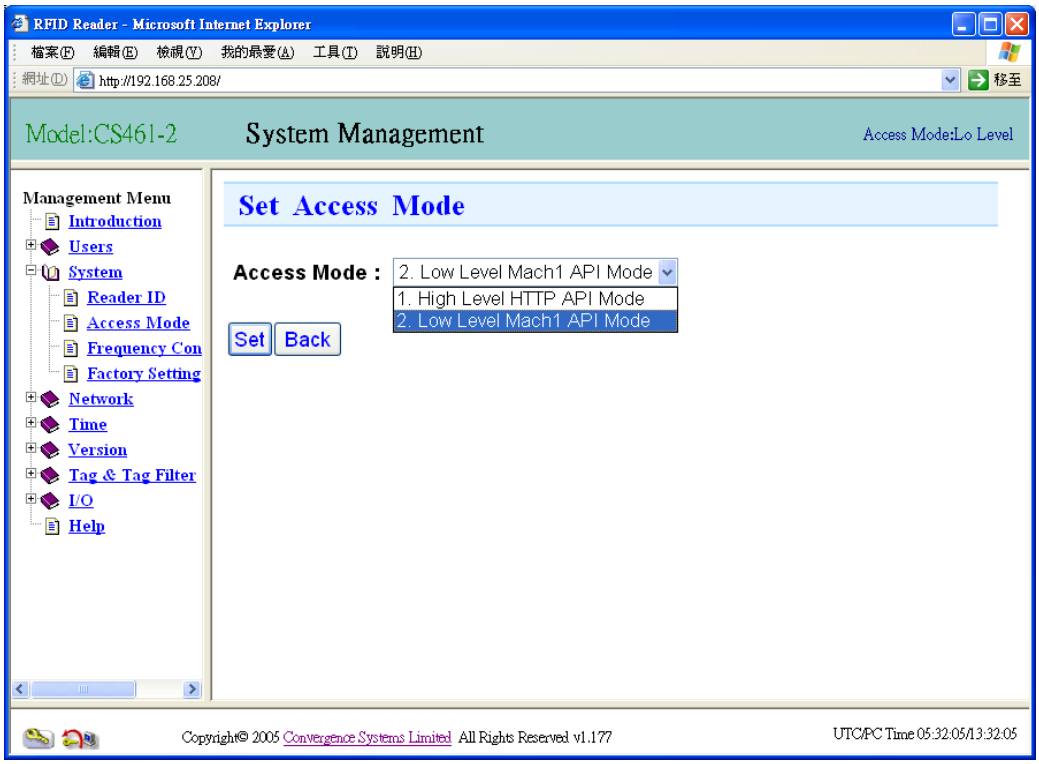


One can then set the unique ID for the reader. This is needed for easy future reference and programming access:



For configuring the reader to be controlled by MACH1 API (Low-level), please remember to set the Access Mode to “Low Level MACH1 API Mode”.

If you require to do other configurations on the web interface (e.g. Network setting, Time settings etc.), you must set the Access Mode to “High Level HTTP API Mode”.

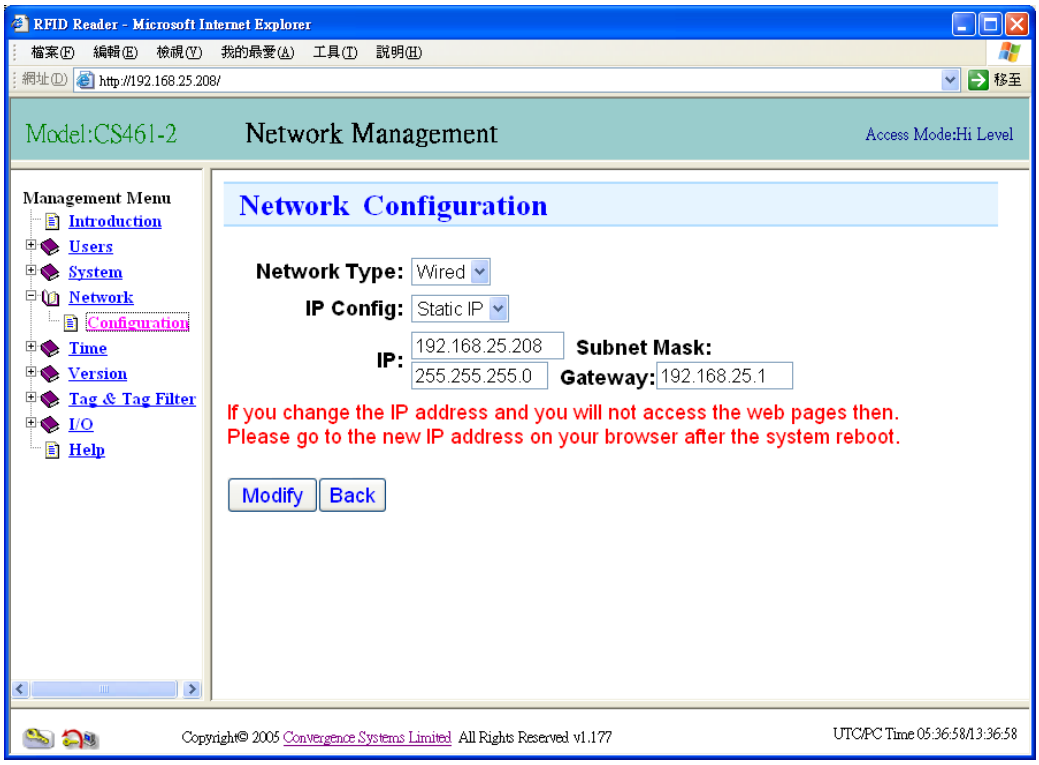


The Frequency Configuration page allows user to configure the country and frequency to be used by the reader. Please refer to the regulatory law of your region for the allowed frequency to be used.

Note: Only USA (FCC) regulatory region is allowed for the existing firmware version.

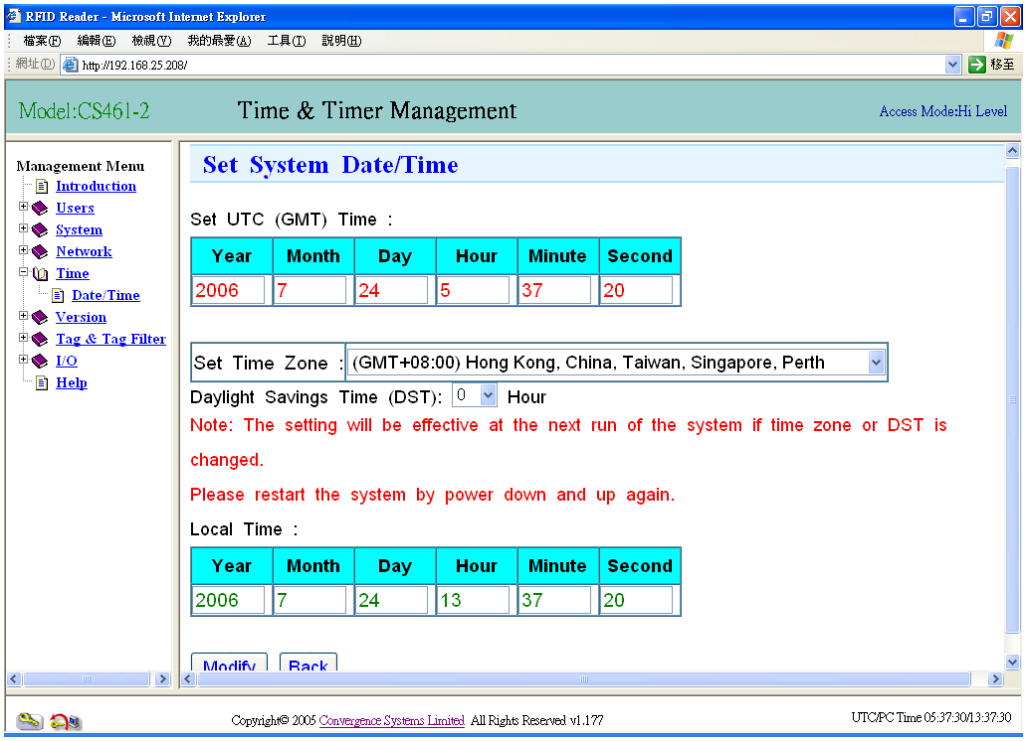
7.1.4 Network Management

Network management page allows the user to set the network parameters.



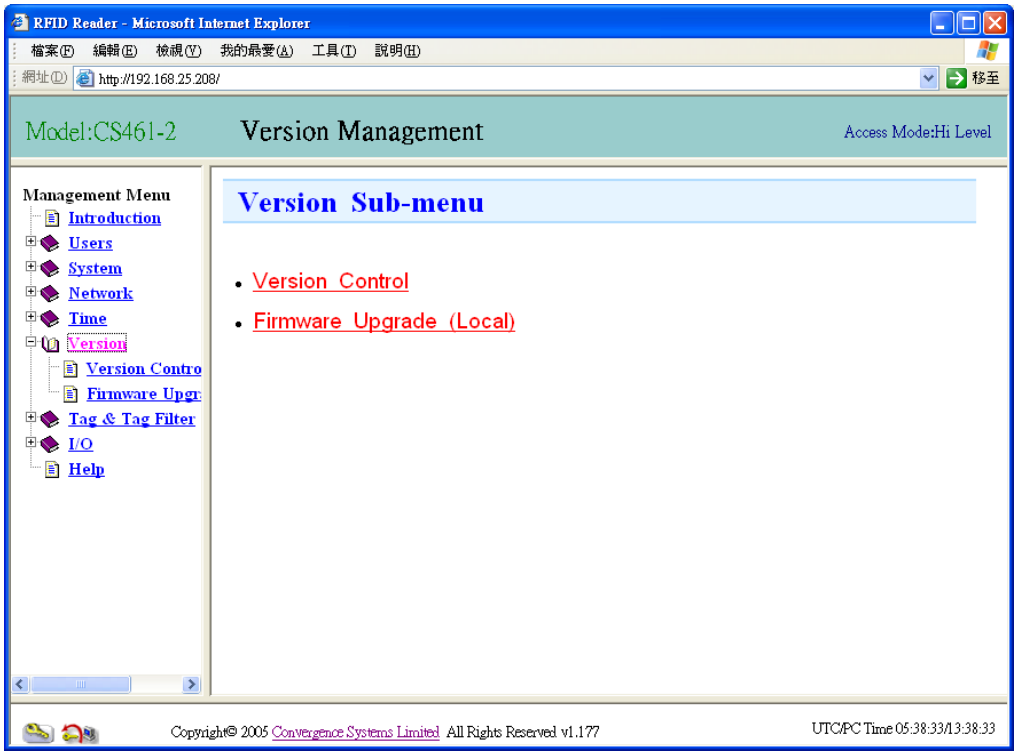
7.1.5 Time Setting

Time page allows the user to set the real time clock inside the reader. Please note that you have to configure the UTC (GMT) time on the reader. The local time will then be calculated based on the time zone you set.

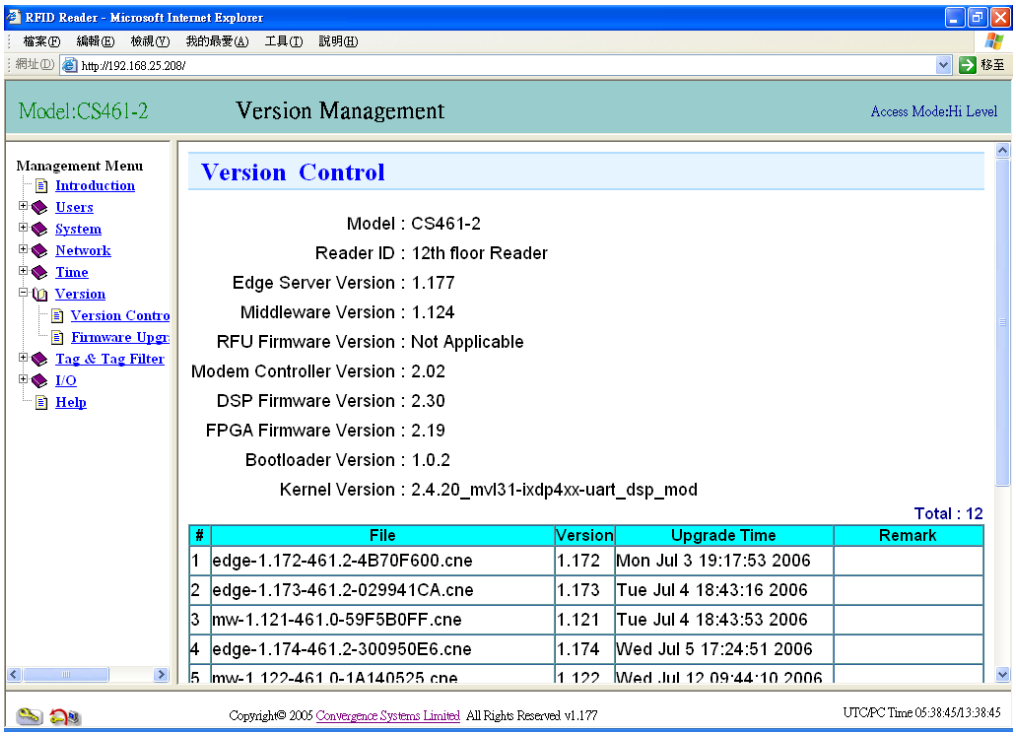


7.1.6 Version Management

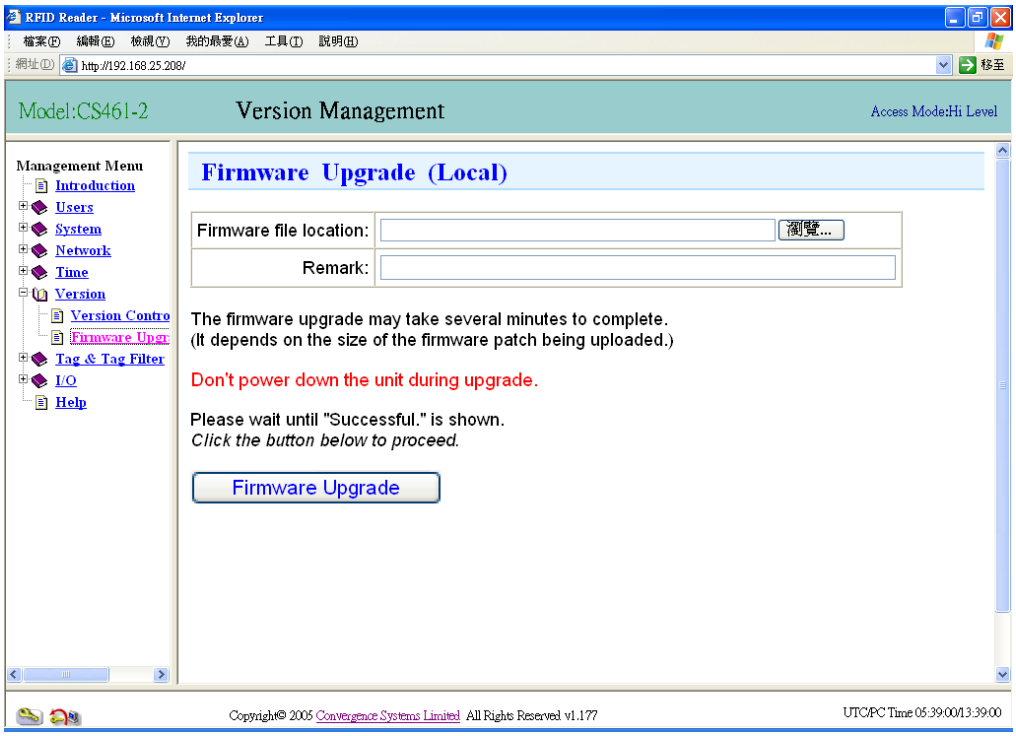
Version management allows you to review the version upgrade history (in the Version Control Submenu), and to do firmware upgrade (in the Firmware Upgrade Submenu).



In the version control sub-menu page, one can see the version number of the software. This is an important page to check if the versions are correct, especially after a firmware upgrade.



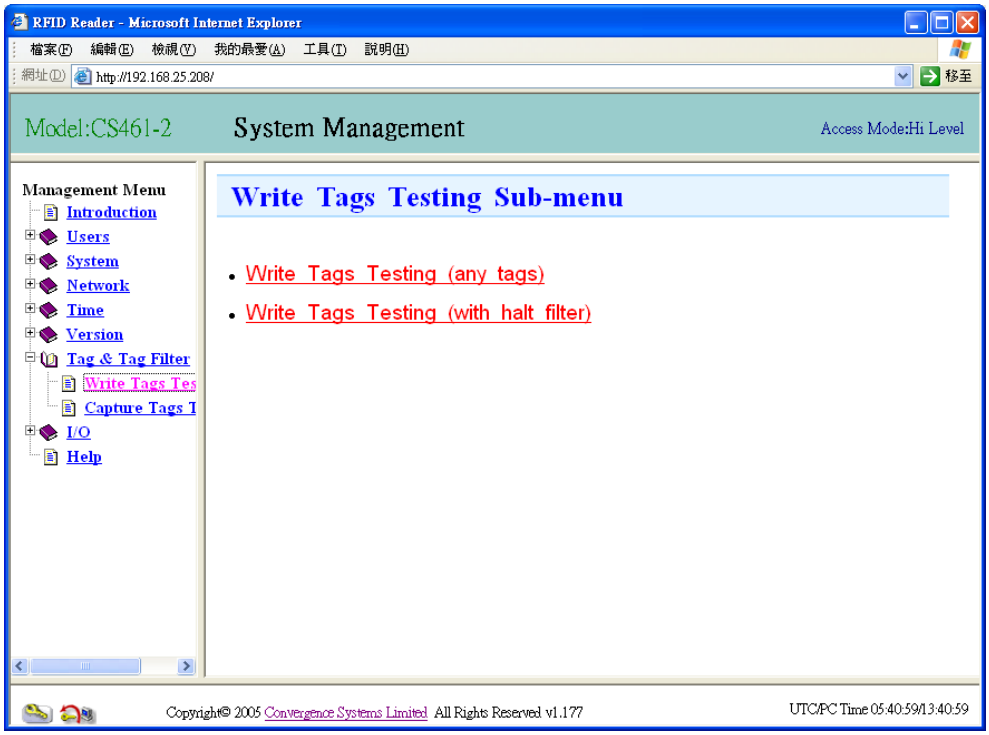
In the firmware upgrade submenu, just press the **Browse** button and find the upgrade file (which the user has already downloaded from CSL website before). Just select the upgrade file with the .cne extension, without doing anything to it, and press open. Then press the **Firmware Upgrade** button. The upgrade takes a few minutes, depending on the size of that particular upgrade. Please wait until you see the success message. The reader needs to be rebooted afterward, either physically unplugging the power supply, or by the web interface (Restart page in System menu).



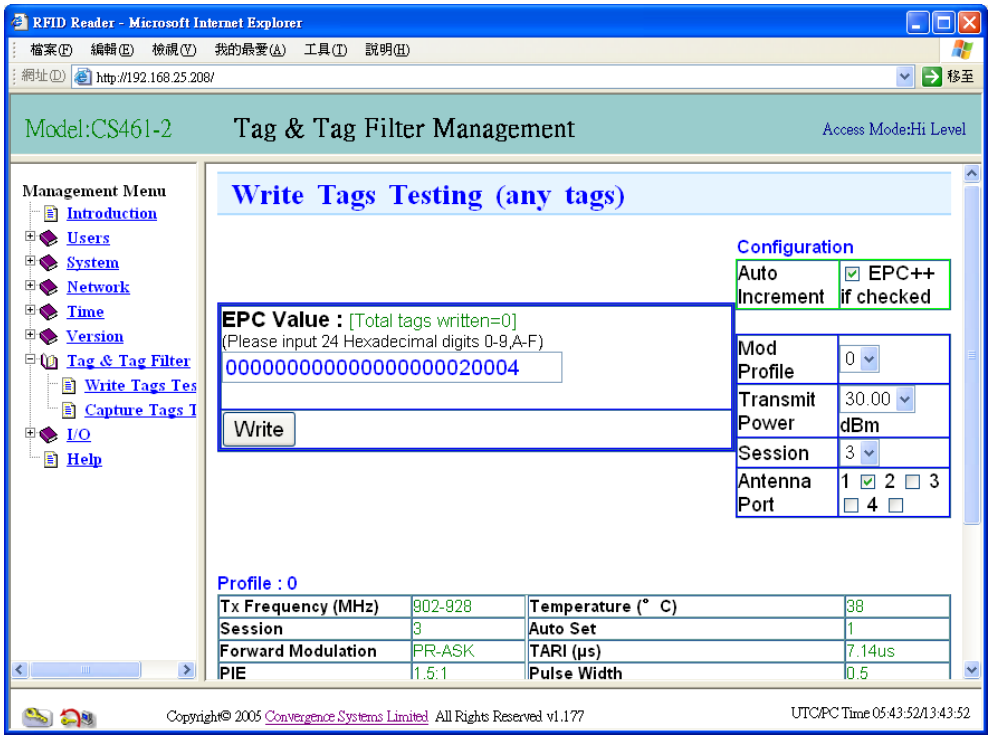
7.1.7 Tag & Tag Filter

Tag & Tag Filter page allows you to read tags and write EPC ID on the tags.

In Write Tags Testing, you can either write EPC ID on any tag (any original EPC ID) or on the tags that match your halt filter setting (the tags that match the filter).

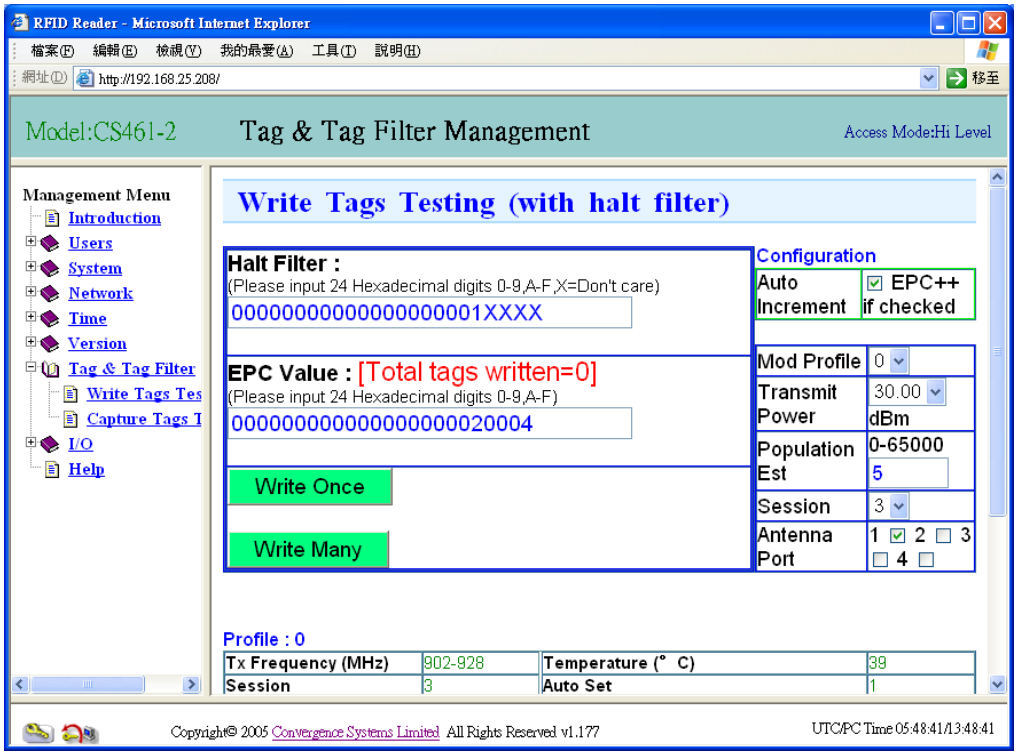


In “Write Tags Testing (any tags)”, you can rewrite any tag’s EPC ID regardless of its original EPC ID. Configure the reader settings, enter the new ID in “EPC Value” and then click the “Write” button to start writing. If you would like the EPC value to be incremented automatically for next write, please tick the “Auto Increment” box.

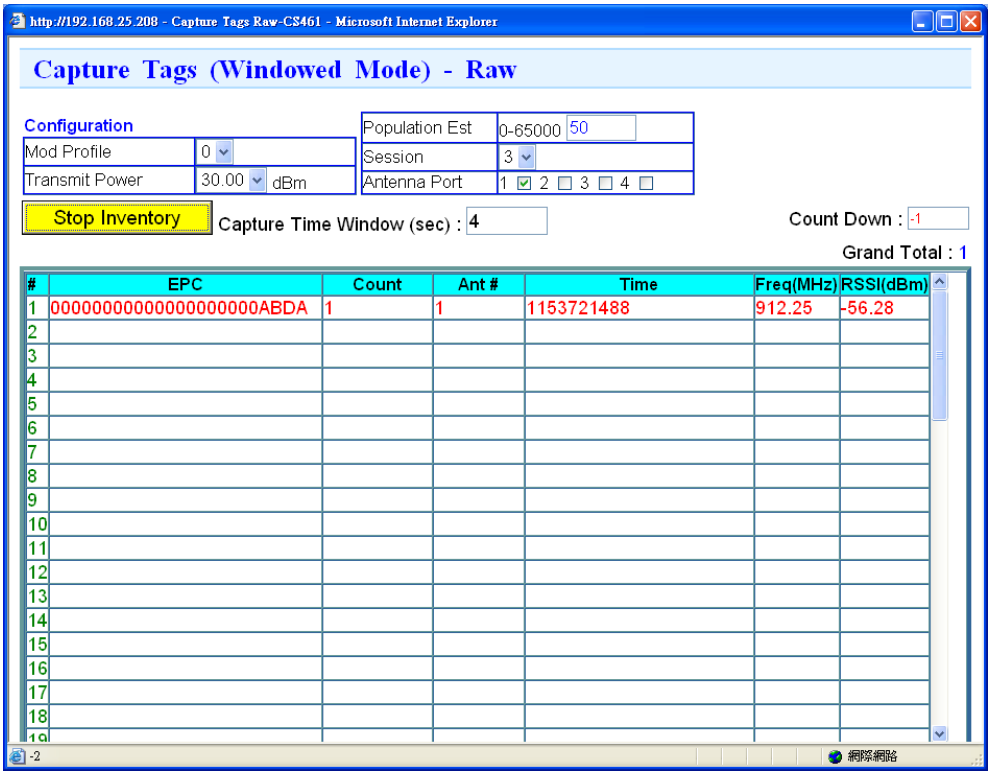


In “Write Tags Testing (with halt filter)”, you can define which tag(s) to be written with new EPC ID. The steps for writing tags are:

1) Enter the original EPC ID of the tag(s) in the “Halt Filter” field (note that you can enter a “X” character as a wildcard or don’t care)
2) Configure the reader settings
3) Enter the new ID in the “EPC Value” field
4) Tick “Auto Increment” box if you want the EPC Value to be increased for each write
5) Click “Write Once” button if you want to write one tag only; or click “Write Many” button if you want to write multiple tags



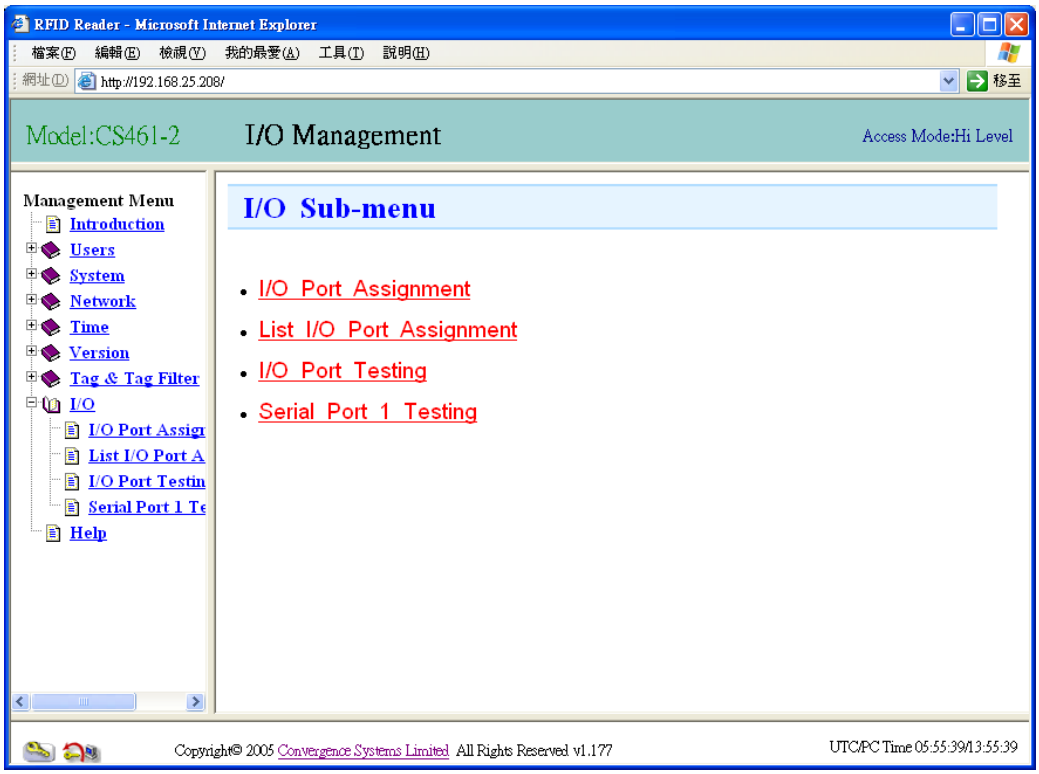
In “Capture Tags Testing”, users can test the reader from reading tags.



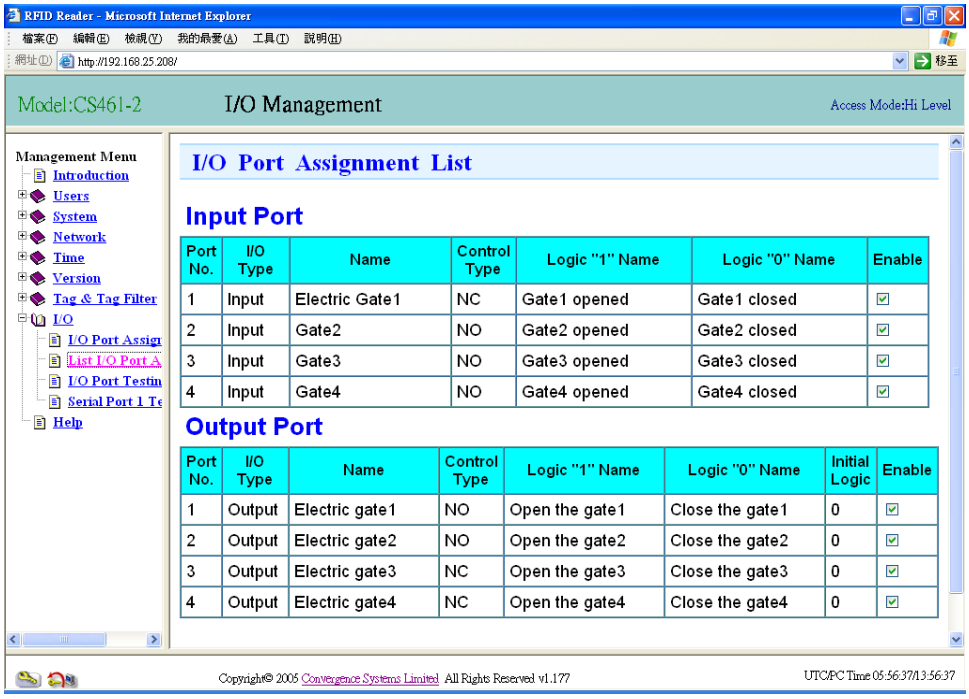
7.1.8 I/O Management

IO management page allows users to define various ports of input and output, giving them logical name for subsequent uses in event and other management.

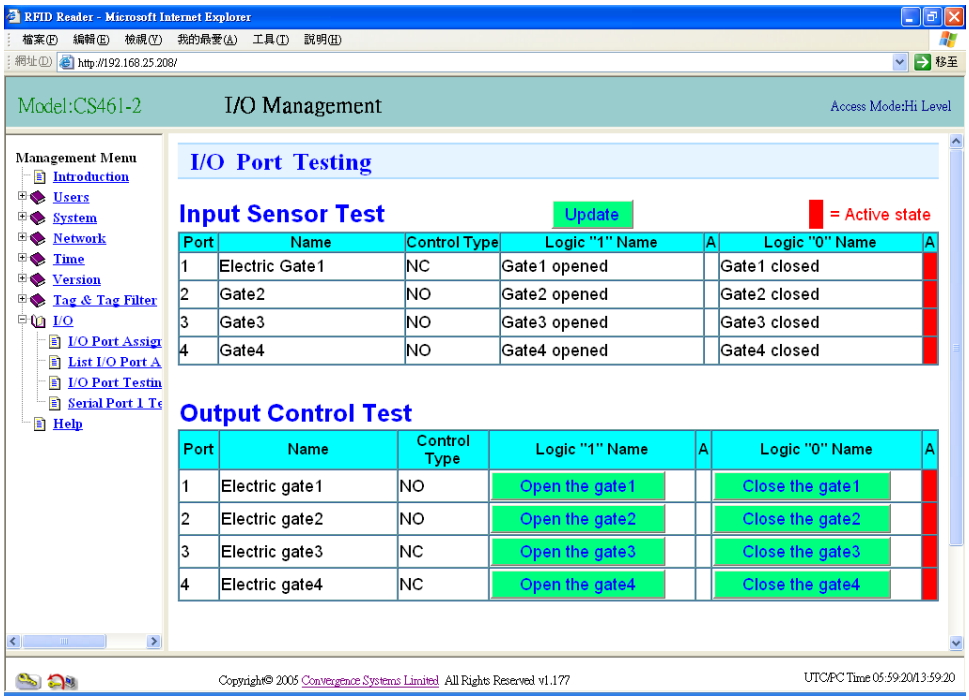
For the details of controlling IO port by High-level HTTP API command, please refer to the Programmer's manual.



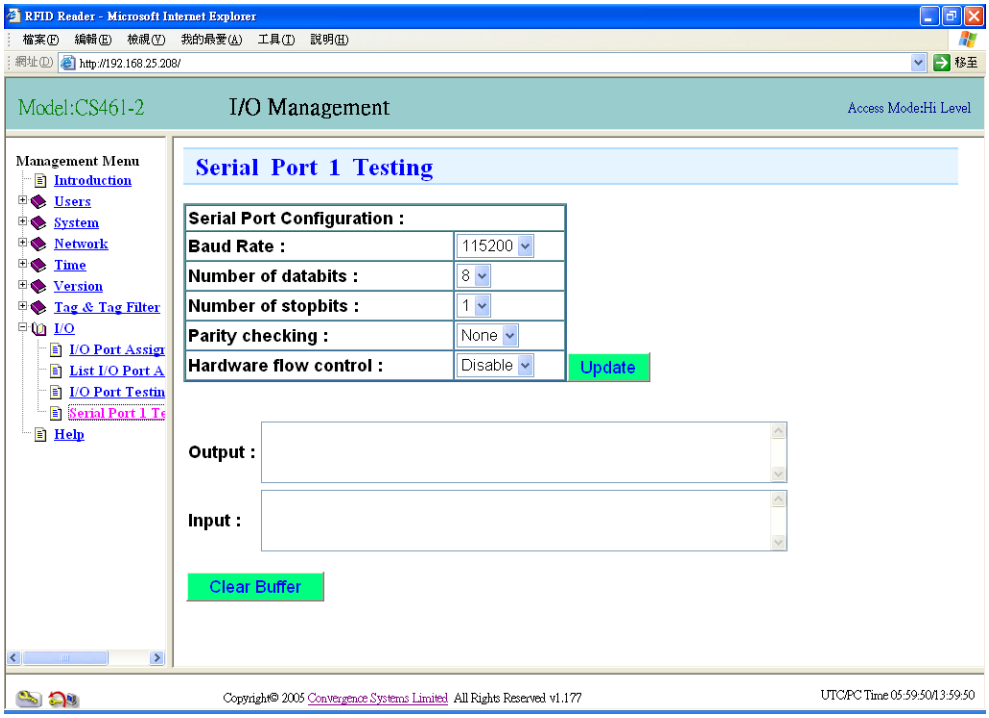
Here is the IO port assignment list page:



Here is the IO Port Testing page, it allows one to look at sensor input (by pressing the update button), and control the outputs for system testing. The username and password for login this page is “test engineer” and “cnernd”.



In “Serial Port 1 Testing”, you can test the serial communication between the reader IO port and the external device.



7.2 CSL Demo Program

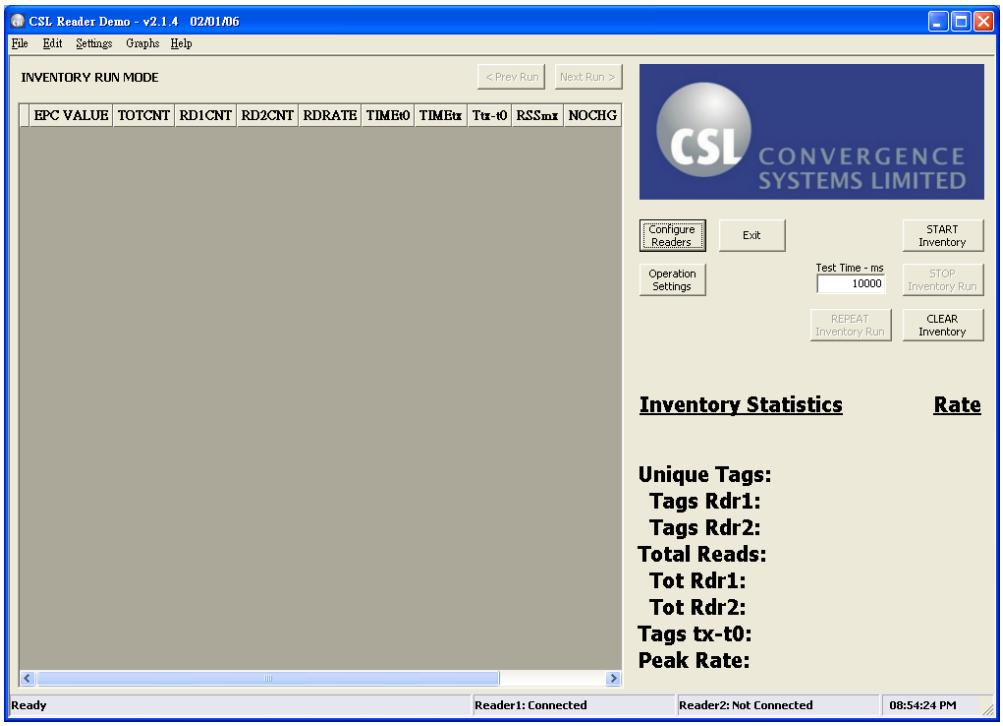
7.2.1 Installing the Demo Program

In addition to the web-based interface, a Windows-based program also comes with the reader for users' quick testing (reader must be set in "Low-level API Access Mode"). Moreover, this program allows users to control up to 2 readers simultaneously to demonstrate the Multi-Reader mode (or Dense-Reader mode). The demo program can be found in the manual CDROM disk and it should be installed onto a PC before using:

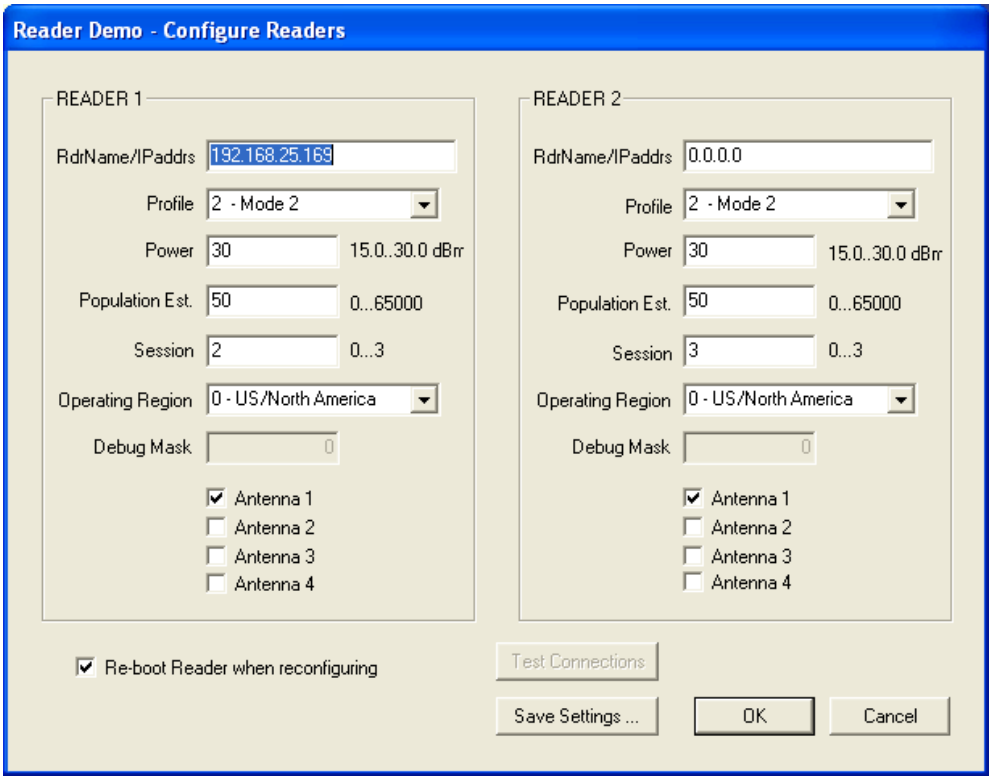
1) Double-click the file "CSLReaderDemo214.msi" on the manual CD.
2) Follow the instructions to install the program on your PC
3) After installation, an icon "ReaderDemo v2.1.4" appears on your PC. Double-click on it to run the demo program.

7.2.2 Using Multi-Reader Application

Click the icon "CSLReaderDemo v2.1.4" to run the program. When the program opens, the first (and if connected, a second) reader's IP address must be entered in the program.



This is done by clicking the “Configure Readers” button. The screen shown below should open. Enter the reader’s IP address in the appropriate window.



At this point, the reader operating mode can be selected. Presently, 4 modes are supported by the reader as shown in the table below.

Operating Mode	**Reader Parameters**
Mode 0: (Max Throughput)	Tari 7.14 us / PIE 1.5:1 / Fwd Modulation PR-ASK / PW 0.5 (long) / LF 640kbps / Rev Mod FM0
Mode 1:	Tari 12.5 us / PIE 1.5:1 / Fwd Modulation PR-ASK / PW 0.33 (short) / LF 160kbps / Rev Mod FM0
Mode 2: (Dense Reader)	Tari 25.0 us / PIE 2.0:1 / Fwd Modulation PR-ASK / PW 0.5 (long) / LF 256kbps / Rev Mod Miller M=4
Mode 3:	Tari 25.0 us / PIE 2.0:1 / Fwd Modulation PR-ASK / PW 0.5 (long) / LF 256kbps / Rev Mod Miller M=8

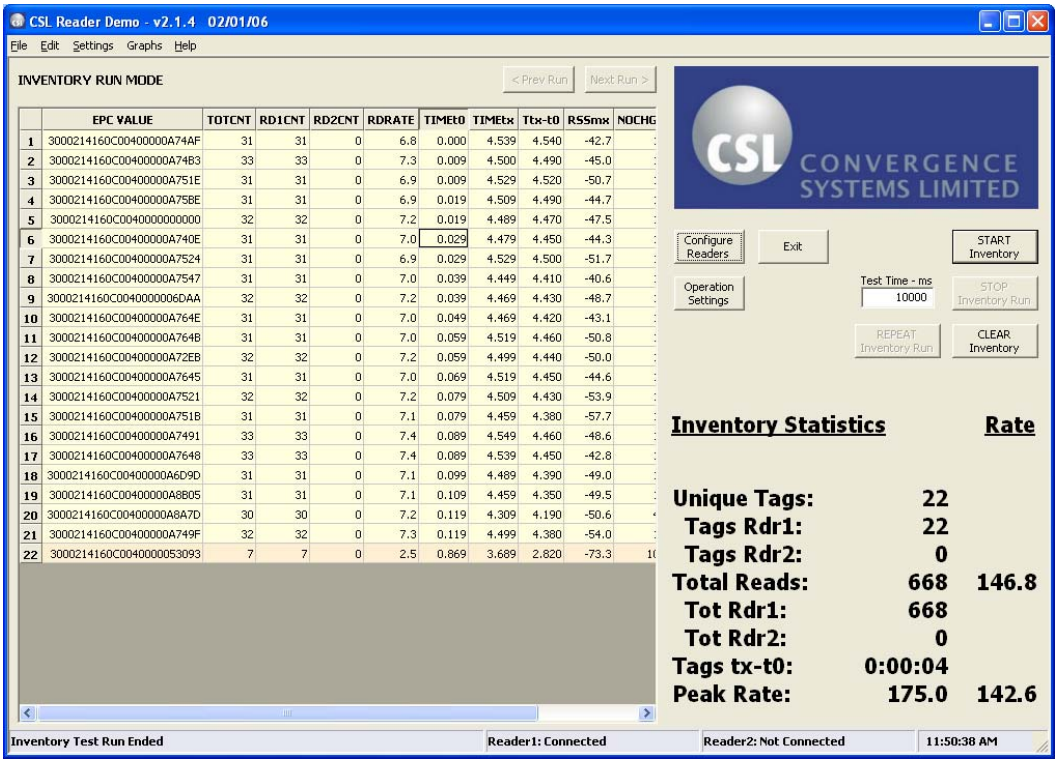
Select the desired mode. For dock door applications where two readers are used, Mode 2, (Dense Reader) must be selected. **It is also very important to select, by checking the appropriate box, the antennas that are currently connected to the reader. The program will not operate if an antenna box is checked and no antenna is connected to that port. However no damage to the reader will result.**

Other reader parameters can also be selected in this window.

Power	Transmit power of the reader (from 15dBm to 30dBm)
Population Est.	The estimated maximum number of tags to be read by the reader at the same time Please input a value as accurate as possible because it can optimize the performance of tag read
Session	Session number that the program connect with the reader. It should be unique for each reader
Operating Region	The region that the application is in operation

After configuring the reader(s), press the "Save Settings …" button and then "OK" button to close this window. It will return to the main screen and attempt to communicate with the reader and setup the selected parameters. If successful, the bottom of the screen will indicate **Reader 1: Connected**. (or "Reader 2: Connected" also if multi-reader is set).

At this point, the readers will read tags placed in the field of the reader. The figure below shows a successful read operation.



The program defaults to a 10 second run, after which the reader will stop. This parameter can be changed by selecting the desired operating time (in milliseconds) in the “Test Time – ms” field. Entering the value “0” results in continuous operation.

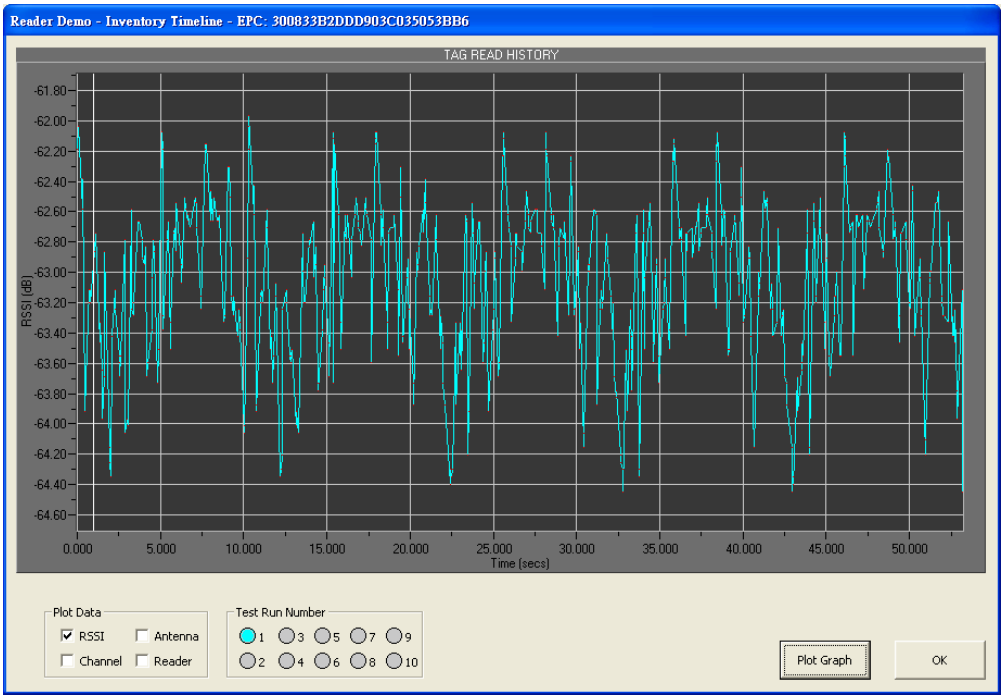
To stop the reading operation, press the “STOP Inventory Run” button.
To start the reading operation, press the “START Inventory” button.
To clear the list of read tag on the left hand side, press the “CLEAR Inventory” button.

To study the detail information of each read of a specific tag, click on the EPC value of that tag on the list and then right-click the mouse. A detail record of every read of that tag is displayed.

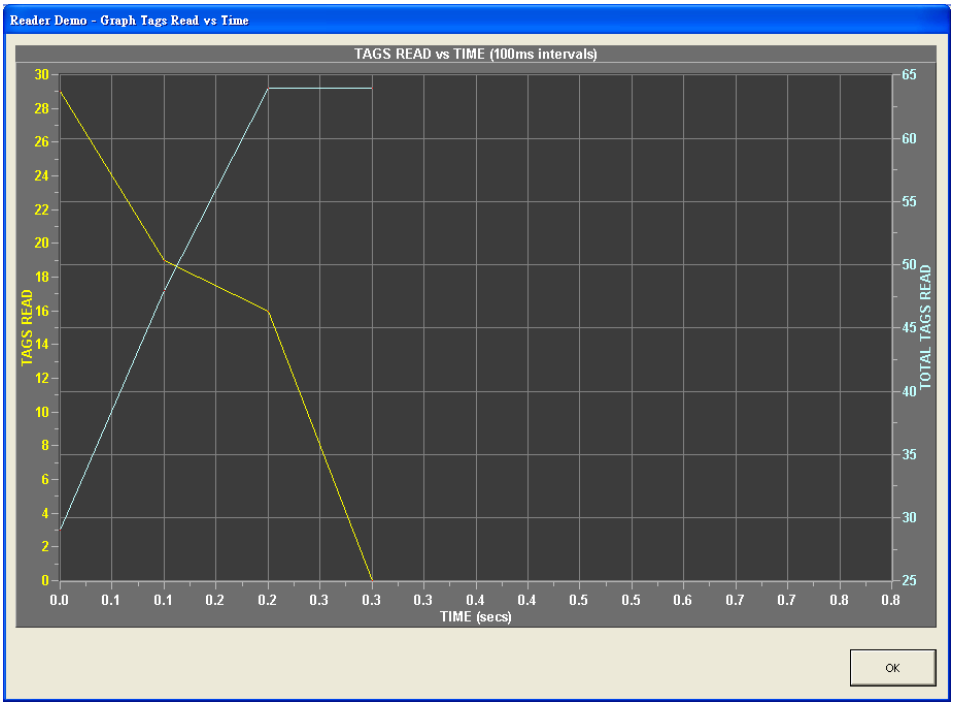
	TIMESTAMP	RUNNUM	RDRID	FREQ	RSSI
1	1143205055.352	0	0	910.75	-62.19
2	1143205055.388	0	0	910.75	-62.04
3	1143205055.650	0	0	904.75	-62.58
4	1143205055.678	0	0	904.75	-62.38
5	1143205055.804	0	0	925.25	-63.92
6	1143205055.827	0	0	925.25	-63.92
7	1143205056.053	0	0	918.25	-63.12
8	1143205056.070	0	0	918.25	-63.20
9	1143205056.136	0	0	918.25	-63.12
10	1143205056.158	0	0	918.25	-63.20
11	1143205056.426	0	0	909.75	-62.86
12	1143205056.447	0	0	909.75	-62.74
13	1143205056.689	0	0	911.75	-63.46

Print... Save... Cancel

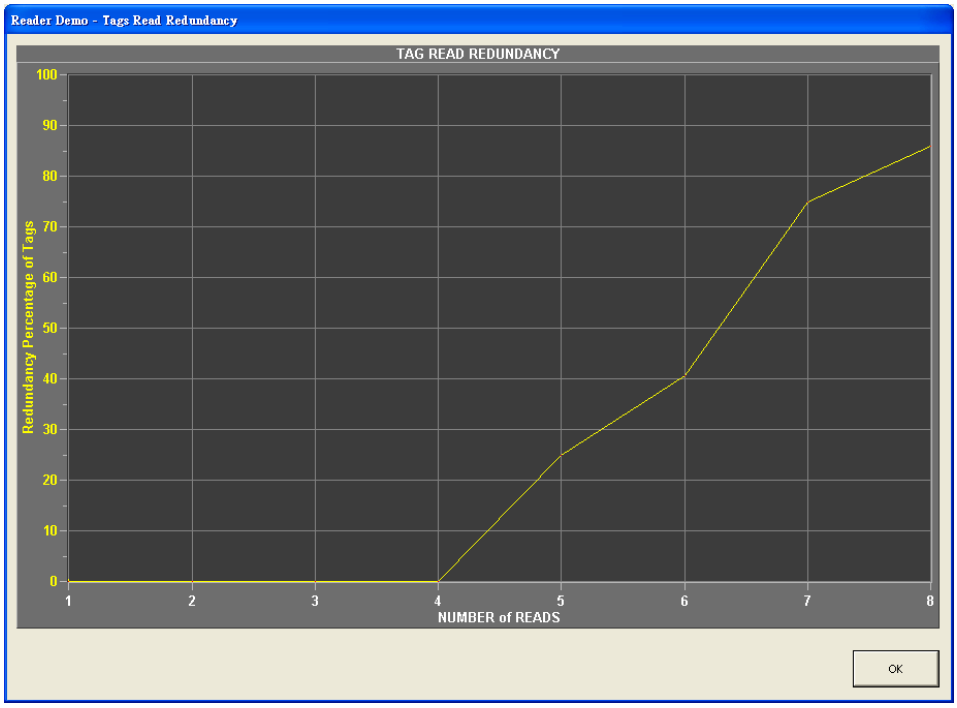
Moreover, different kind of graphs for the tag reading operations of the reader(s) can be generated for further analysis. Click the “Graphs” on the top to select different kind of graphs.



Tag Read History



Tags Read vs. Time



Tag Read Redundancy

7.3 Programming Interface

The CSL CS-461 reader has a set of Application Programming Interfaces (API). Details of programming methods, please refer to the series of Command Set Manuals.

6) CSL High Level API Manual
   - Make sure the reader is configured as “High Level API Mode” in Access Mode

7) CSL Low Level API Manual
   - Make sure the reader is configured as “Low Level API Mode” in Access Mode

8 RFID Application Guide for System Integrators

8.1 Introduction

RFID (radio frequency identification) is a wireless means to obtain a unique ID that can identify a product (similar to barcode that however requires optical line of sight). Since 2004, it was applied by companies in USA and Europe successfully to various business processes and brought major cost benefits. Because of the success of these early adopters, such as Walmart (USA) and Mark & Spencer (Europe), there is a growing trend throughout the world to replace barcode (or augment) with RFID. The advantages of RFID over barcode are widely publicized, consisting of the following:

Features	RFID	Barcode
Line of Sight	Line of sight is not required	Must be line-of-sight visible – items must be tediously separated out for reading, very inconvenient
Storage	Store data up to 1 Kbyte	No storage capability
Anti-Counterfeit Ability	Hard to counterfeit, hard to find (can be stowed inside item)	Easy to counterfeit, always exposed outside and therefore easy to copy
Processing Speed	Automatic processing possible at very high speed	Processing has to be manual in most cases, with very low speed and throughput
Bulk Reading	Many tags can be read at the same time – virtually parallel reading	Must be read sequentially
Durability	Durable, usually safely stowed inside item.	Easily scratched, wrinkled or wetted beyond reading.

RFID can be applied with the following purposes:

1. Supply chain optimization
2. Asset tracking
3. Inventory control
4. etc.

Benefits of RFID include:

1. Increase supply chain velocity
2. Reduce human involvement (cost, error, hiring cycle and other issues)
3. Enhanced visibility (tracking, scheduling, planning)
4. Enhanced security (total visibility monitoring, zonal tracking)
5. Real time supply chain re-route (dynamic multi-destination fulfillment)
6. etc.

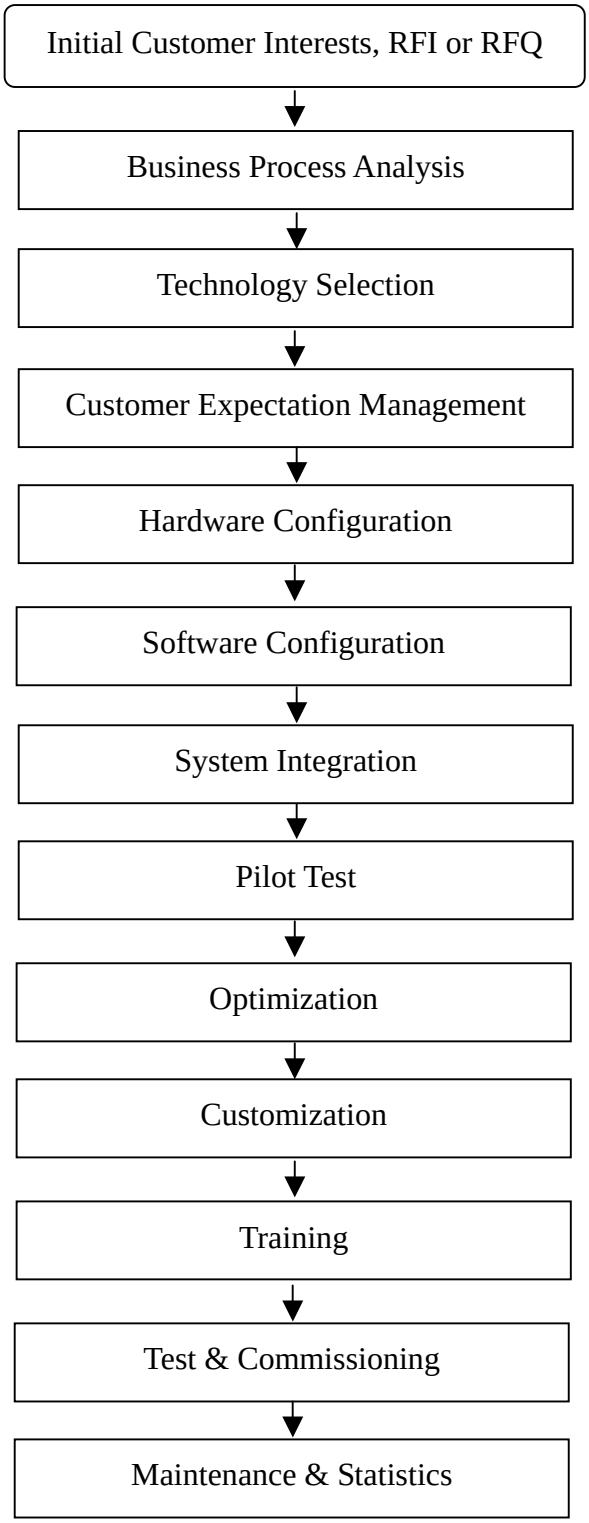
Physical locations where RFID can be applied include:

1. Distribution centers
2. Warehouses Shelves
3. Warehouse Loading/Unloading Zone (Yard Management)
4. Retail shops in conjunction with fulfillment center
5. Returns & warranty processing office
6. Vehicle windshields
7. etc.

It is widely believed that the adoption of RFID will happen in the following sequence in terms of company category:

1. Mandate affected units (suppliers to Walmart, DoD, etc.)
2. High value products
3. Fast moving assets
4. etc.

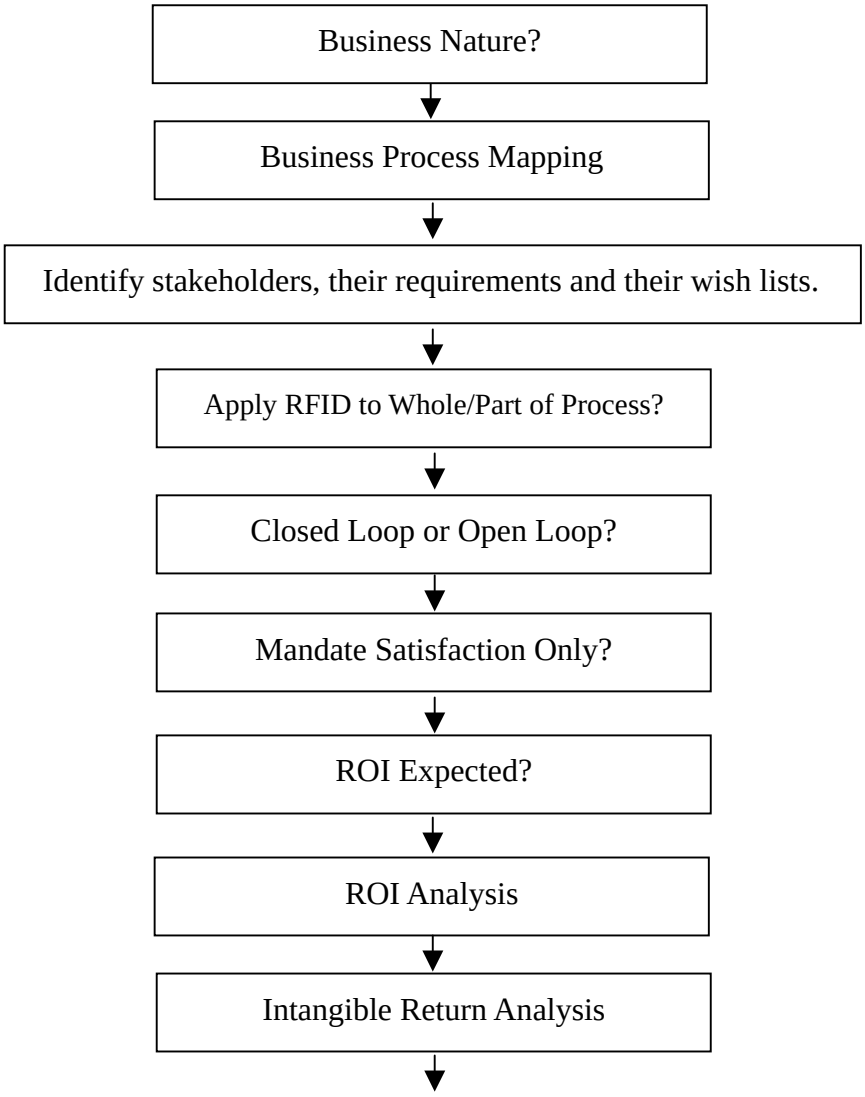
The application of RFID to a company or a group of companies in a supply chain has to be executed systematically and methodically. The following is a flowchart that describes a typical application process:

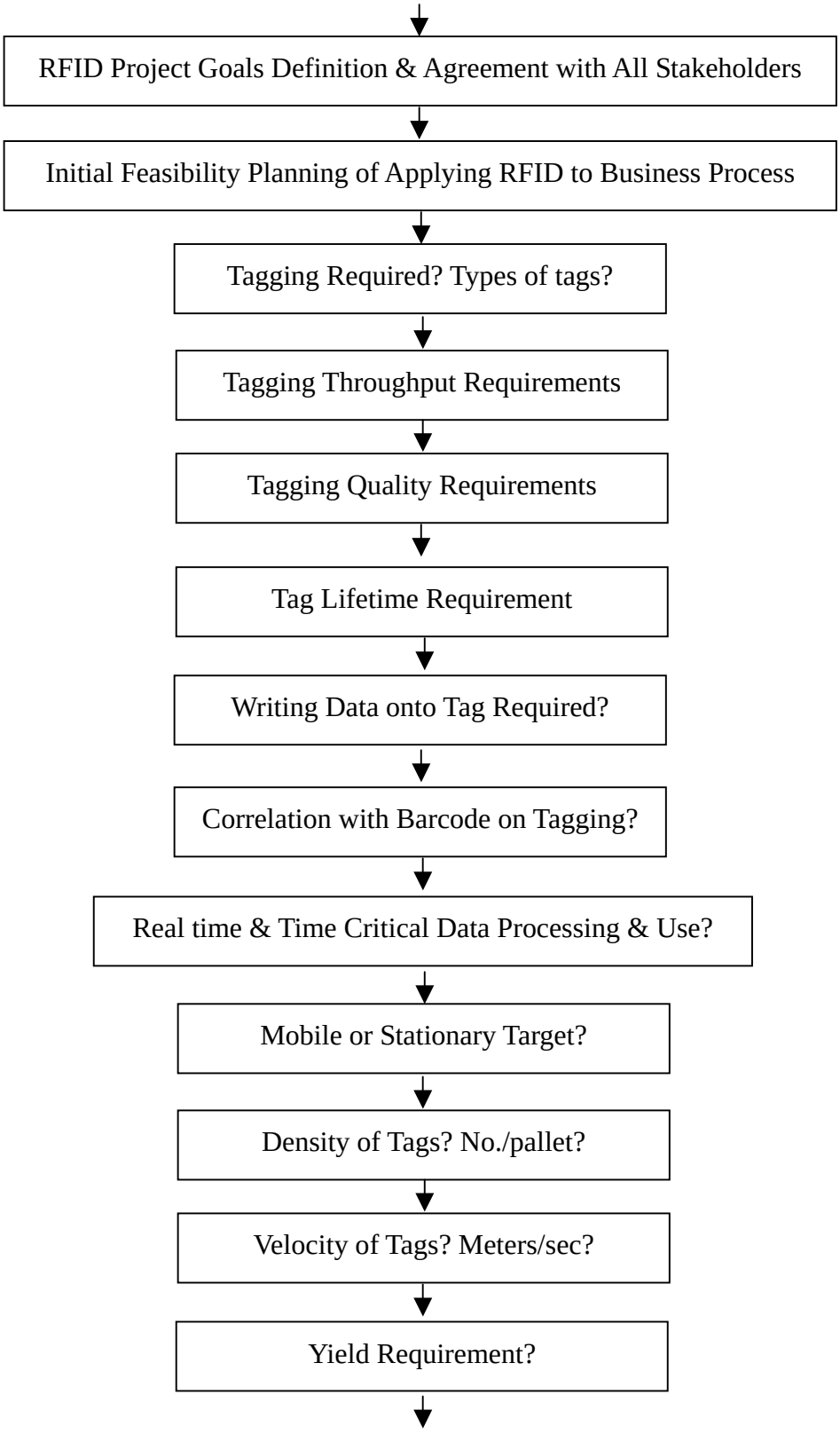


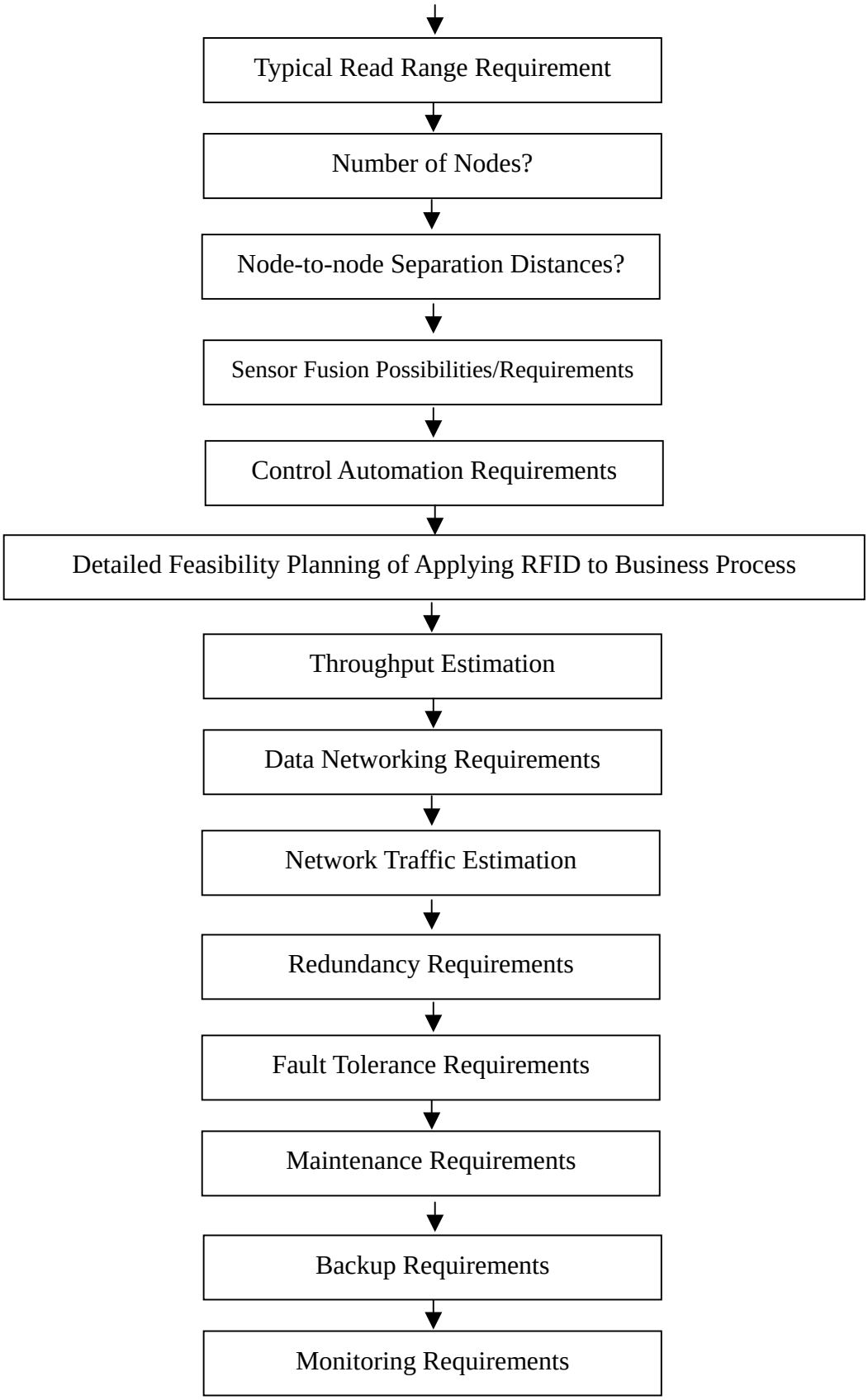
8.2 Application Details

8.2.1 Business Process Analysis

The business process of the customer must be analyzed carefully to find places where the RFID tagging and reading can occur. The system integrator may be applying RFID to the whole process or may only be able to apply RFID to part of the process. The most important principle is NOT to force change the business process to adapt for RFID implementation, but to have RFID implementation slip in as effortlessly and as un-noticeably as possible.

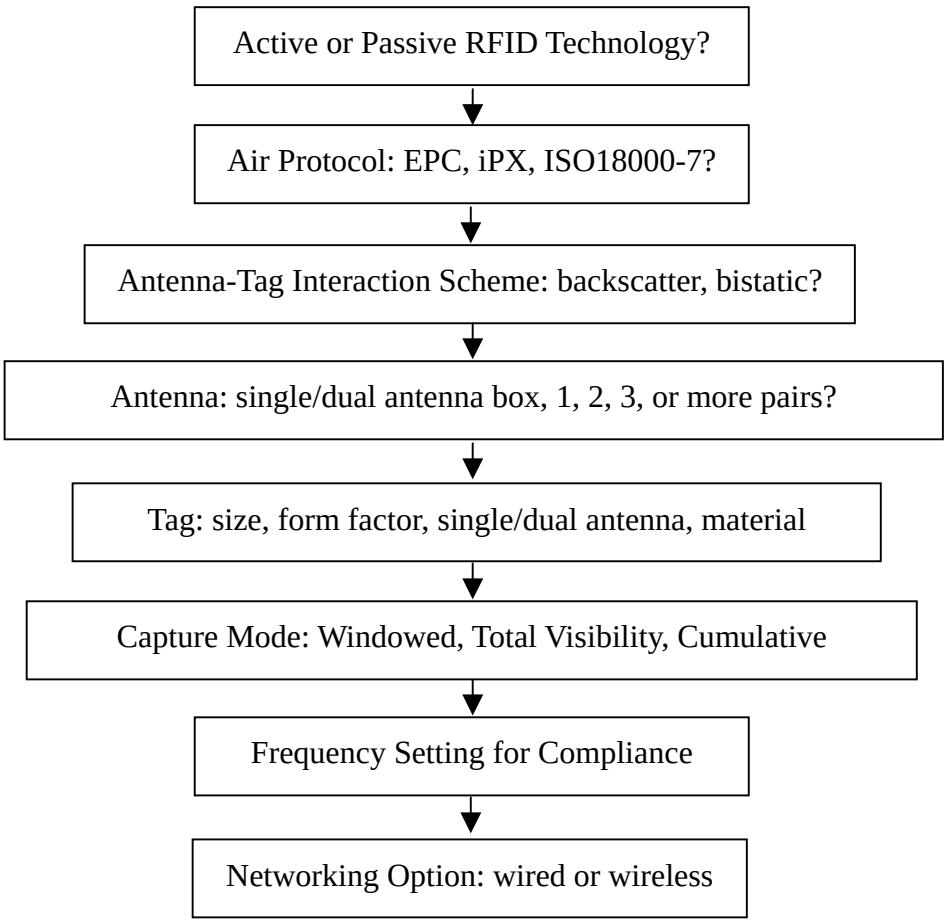






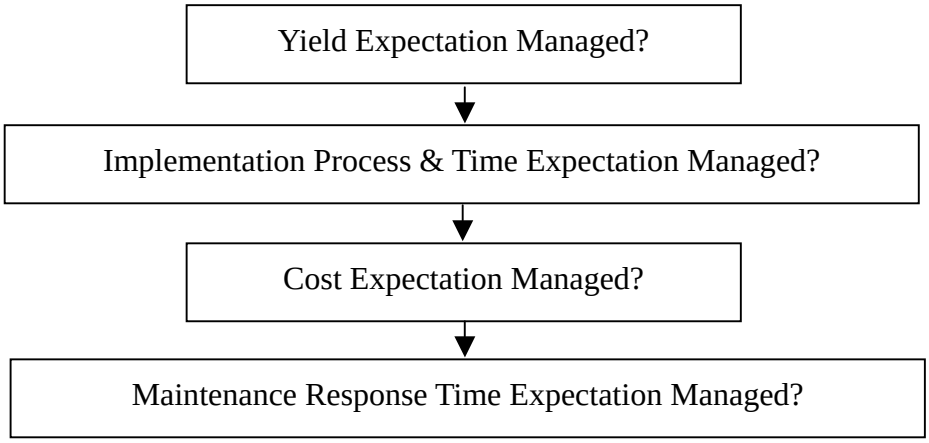
8.2.2 Technology Selection

Once the points where the business process allows for RFID implementation is found, the most appropriate technology must be chosen for the job. The following are questions to help you choose the appropriate technology:



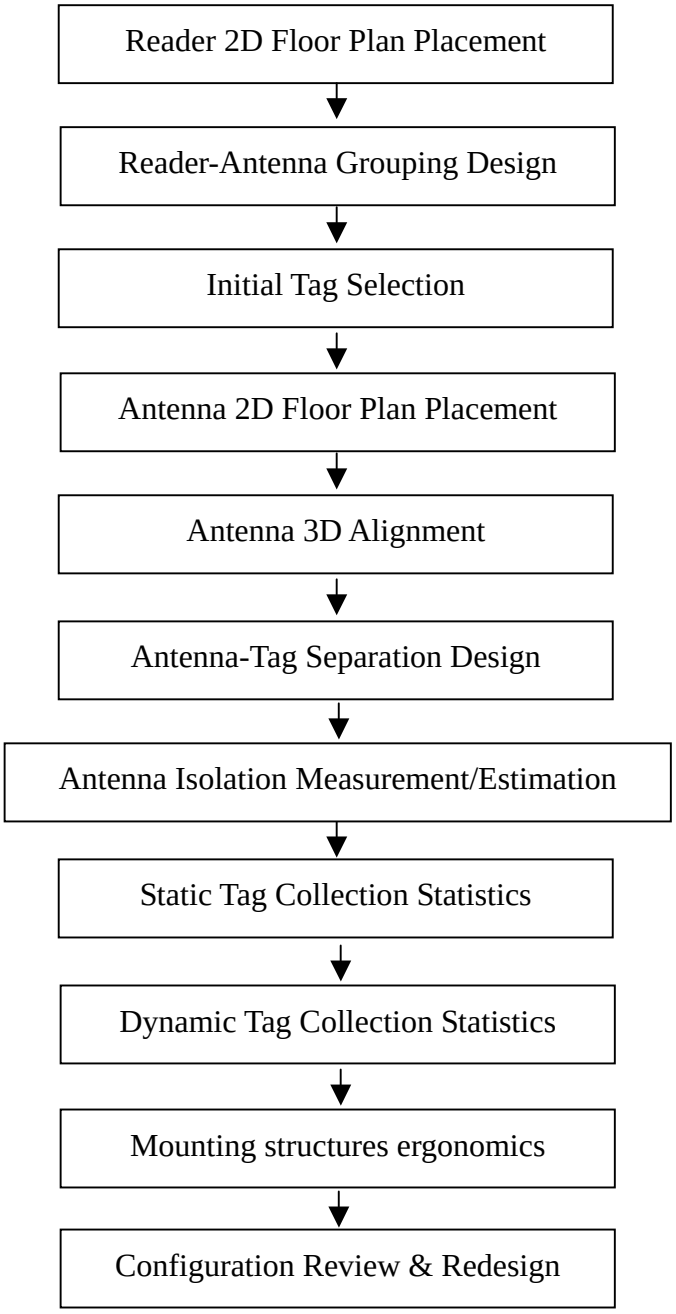
8.2.3 Customer Expectation Management

Customer expectation must be well managed. It is the job of the system integrator, particularly the sales person, to warn the customer away from expecting perfect scores. The truth is, even if 100% read is not achieved, the user can still benefit (in the sense of ROI, efficiency, lead time, cycle time, etc.) to a substantial extent. It is this extent that should be considered as the result, not a 100% score. It is almost like getting married to a man or woman – you will never find the perfect half, but even if she or he is not perfect, you still get to enjoy from the marriage.



8.2.4 Hardware Configuration

Hardware configuration consists of designing and defining what reader, antenna and tag combination will be implemented at each of the nodes in the business process. It is not a pure drawing board exercise, as some kind of minimally realistic testing must be implemented even at this stage to help better define the hardware configuration that in turn can give more insight for software configuration and system integration.



8.2.5 Software Configuration

Software configuration of the reader is very important – it ensures the reader will operate exactly as the business process requires, not more or not less.

The following page has a flowchart that the system integrator needs to go through in order to set up the software.

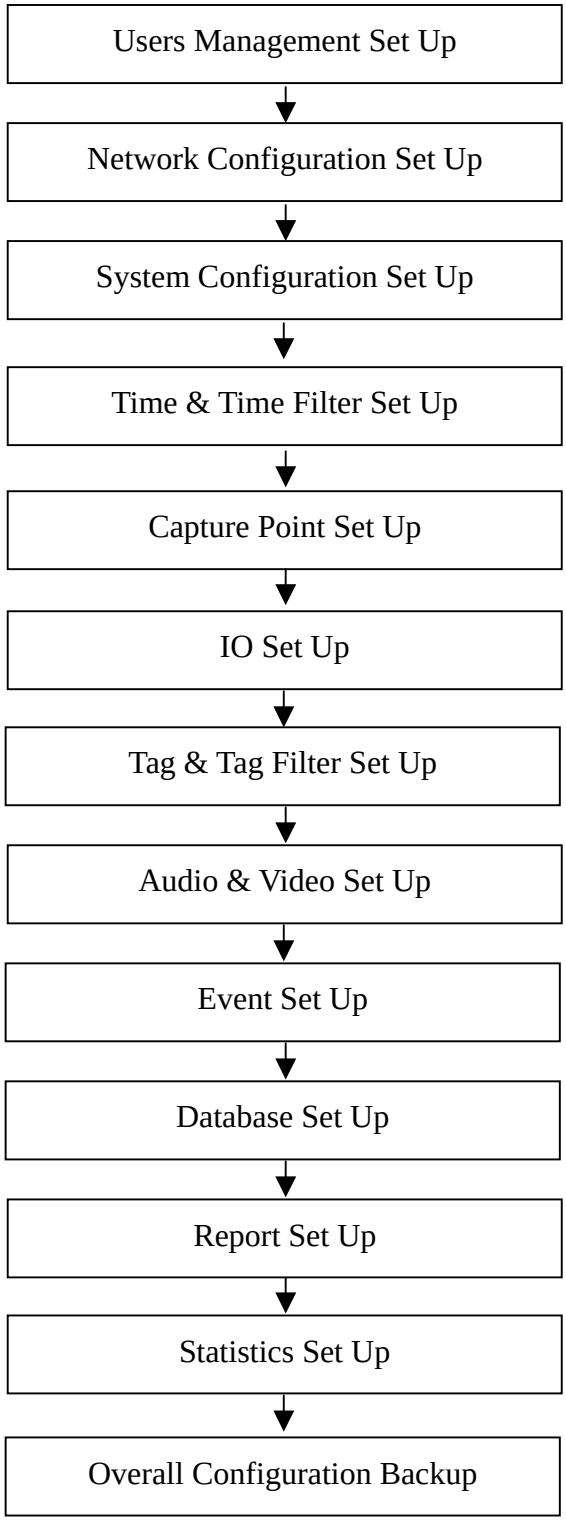
The first step is to configure the users parameter, such as operator name, ID, password, etc. The second step is to configure the networking parameters, such as IP addresses, access point SSID, etc. The third step is to configure system parameters, such as reader ID, frequency setting, tag baud rate, capture mode, etc.

The third step is to configure time and time filter, such as system date and time (hour, minute and second), time filter (define various time intervals, time slots, repeat modes), etc. The fourth step is to configure capture point, such as capture point type, capture point area, capture point details.

The fifth step is to configure IO, such as sensor input name, control output name, default positions, etc. The sixth step is to configure tag and tag filtering, such as tag group, tag filter, etc. The seventh step is to configure audio and video, such as audio messages and video messages resident path (remote or local).

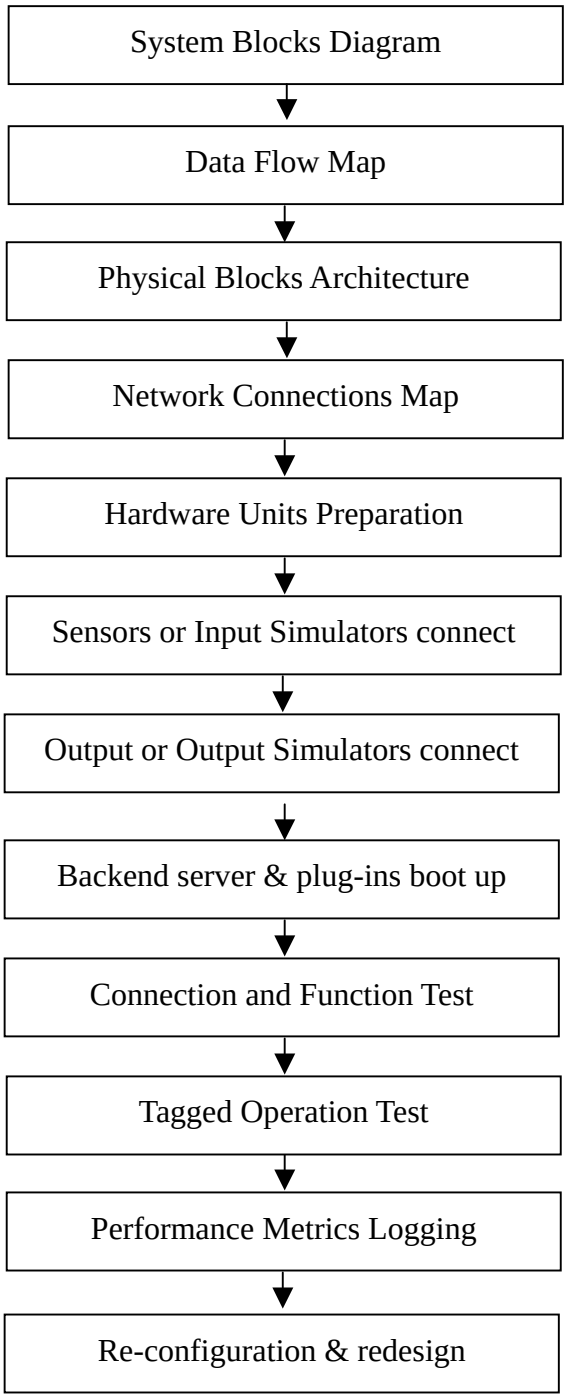
The eighth step is to configure event, such as triggering logic, resultant action, event sequencing, etc. The ninth step is to configure database, such as database fields, etc. The tenth step is to configure report, such as report definition, etc.

The eleventh step is to configure statistics, such as parameters for long term monitoring, etc. The twelfth step is to back up the set up into a standard configuration set up file.



8.2.6 System Integration

The actual system integration should most desirably be carried out in two steps: 1. in house integration and test; 2. onsite integration and test.

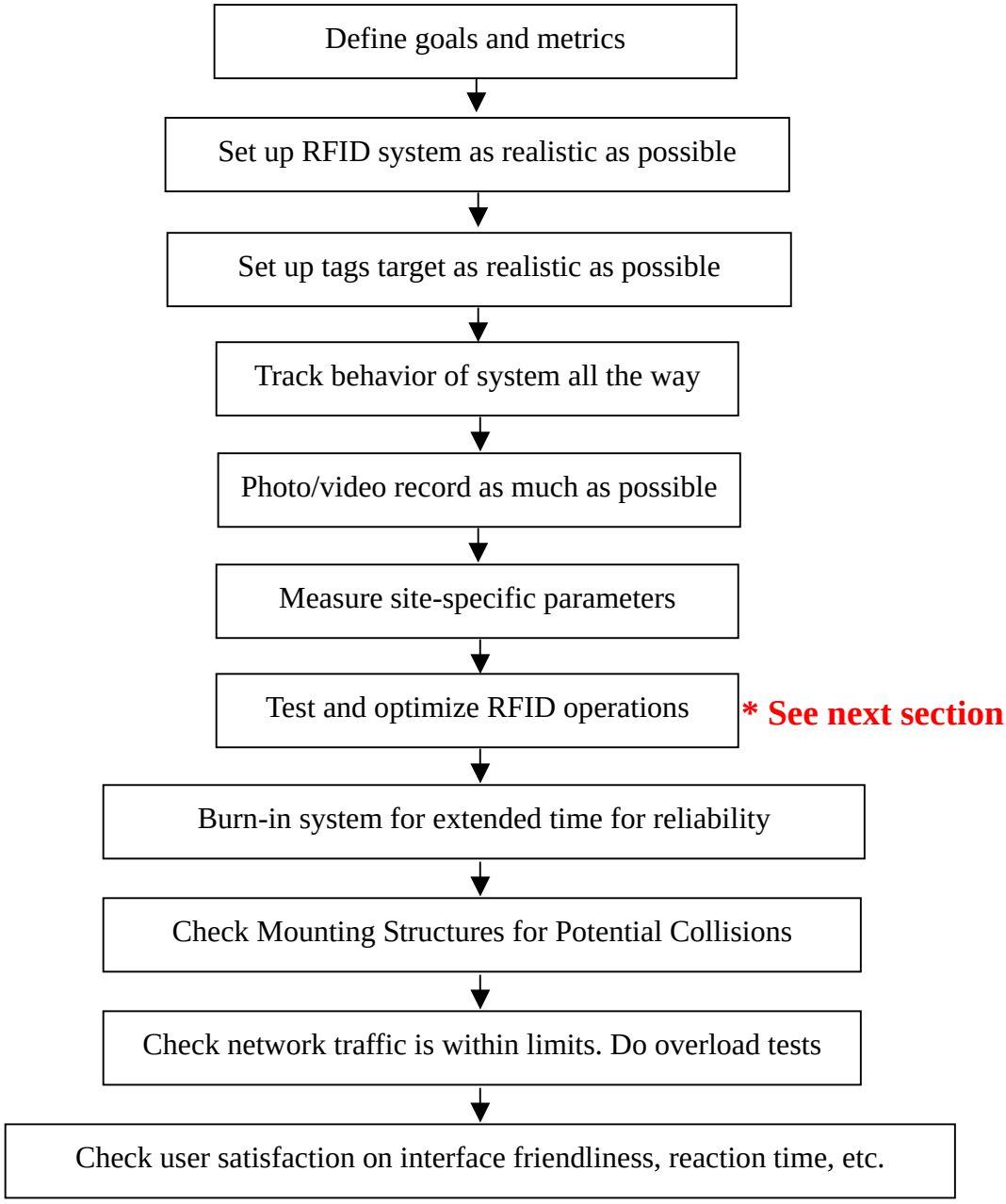


8.2.7 Pilot Test

Pilot test must of course be done on site. The unique building infrastructure and environment of the end-customer venue can result in dramatically different performance (worse, usually) scores compared to that in the system integrator's own office. Therefore pilot test must be done on site.

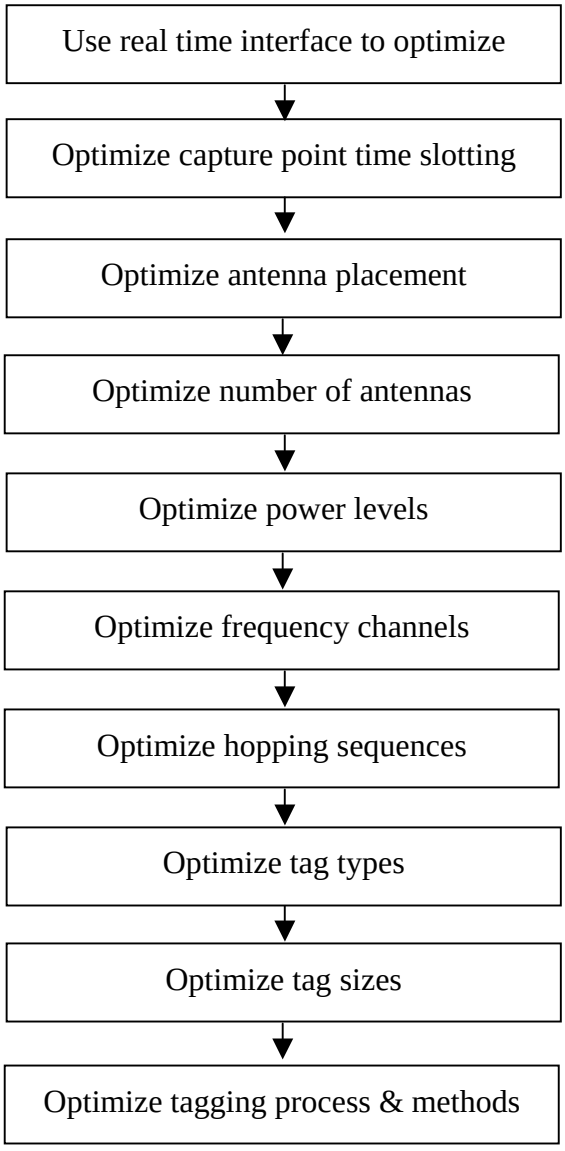
The system integrator, when testing the set up in end-customer's venue, should endeavor to put the set up directly at the position that it plans to be, or in a place that most closely resembles that of the final site. If the site does not run round-the-clock shifts, then it is OK to do the initial testing when it is off-shift and temporarily clearing up the site for testing (if something is in the way). Eventually when good enough results are obtained through tuning and optimization in off-shift time, then the testing should be conducted in the actual shift when the operation will happen in the future. The emphasis on having the environment as real and true as possible is due to the fact that wireless emission is a very site specific and dynamic event. The propagation and scattering behavior is different from site to site. The noise floor can be different in the day and in the night. There is no pilot test better than doing it right at the spot and right at that time.

The following are basic steps for pilot testing (please also refer to next section of optimization):



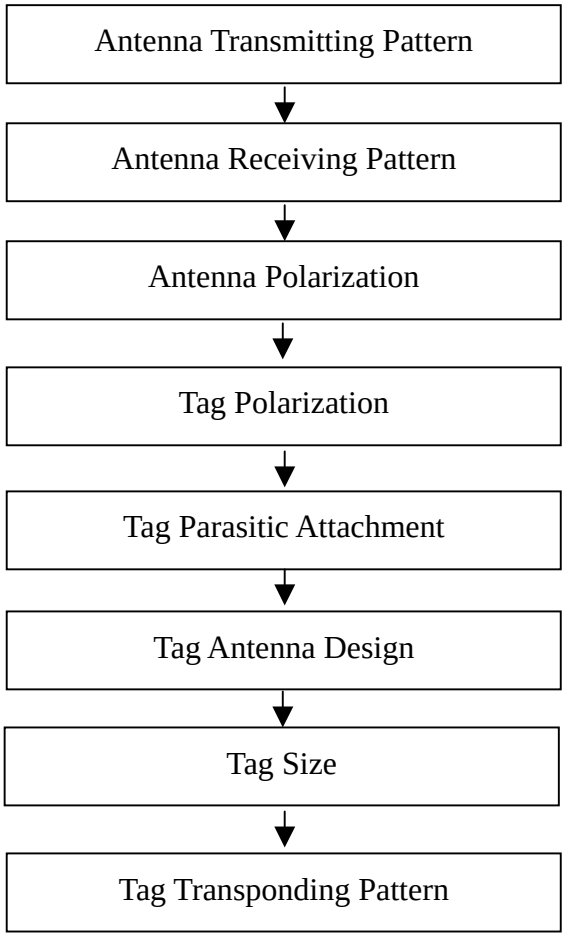
8.2.8 Optimization

Optimization of the performance of the RFID application in business processes is the most difficult step. It is in this step where the variation of performance caused by the law of physics has to be tackled. The following are a few questions that may help. However, due to the unfortunate fact that RFID application involves too many topics: RF transmitter circuits, antennas, propagation (static and dynamic), scattering (backscatter and bistatic scattering), RF receiving circuits, software (all layers), it is not an easy task to give a “10 steps to successful RFID implementation” rule based implementation guideline that works in all environment!



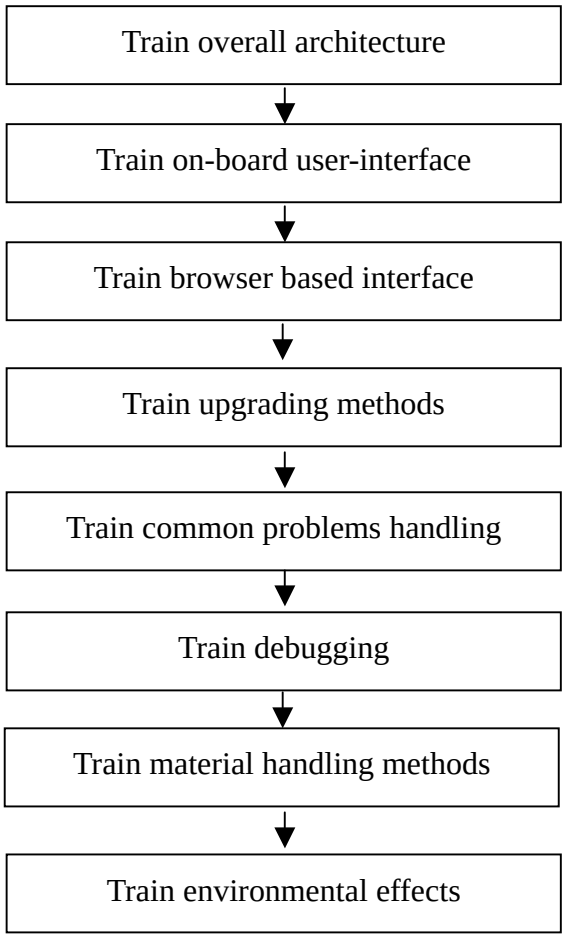
8.2.9 Customization

Customization is the step that comes out of optimization. If, after intense optimization, the performance still is not acceptable (or the customer will not accept a lowering of their performance expectation), then some customization may be necessary. The following are just a few possibilities and suggestions for customization. Note that these customizations require the cooperation of the solution provider (i.e. the manufacturer of the products). Very few solution providers are willing to do this without good business justification, though.



8.2.10 Training

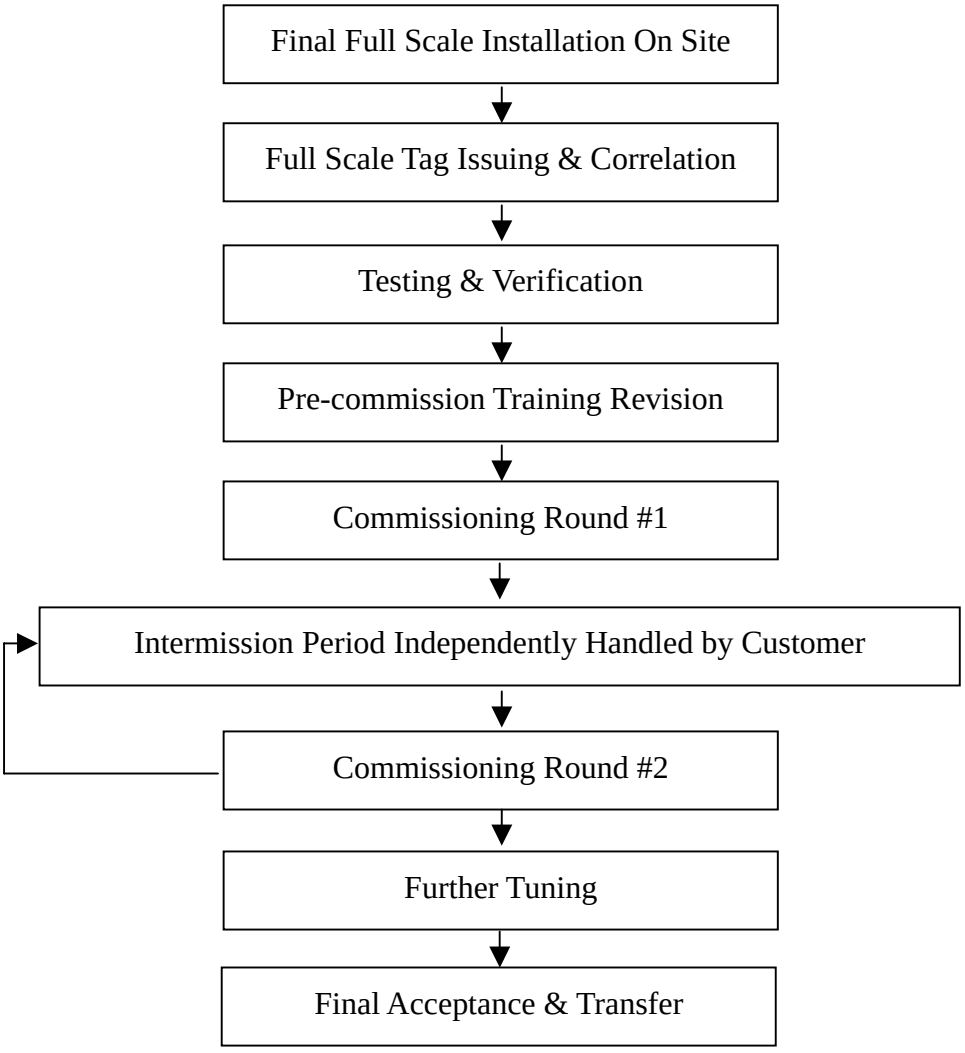
Training is an extremely important step where the operators of the RFID system in the end-customer company must be taught the basics of the operation, plus the necessary tricks in day-to-day trouble shooting and fault isolation – up to a certain extent, of course.



8.2.11 Test & Commissioning

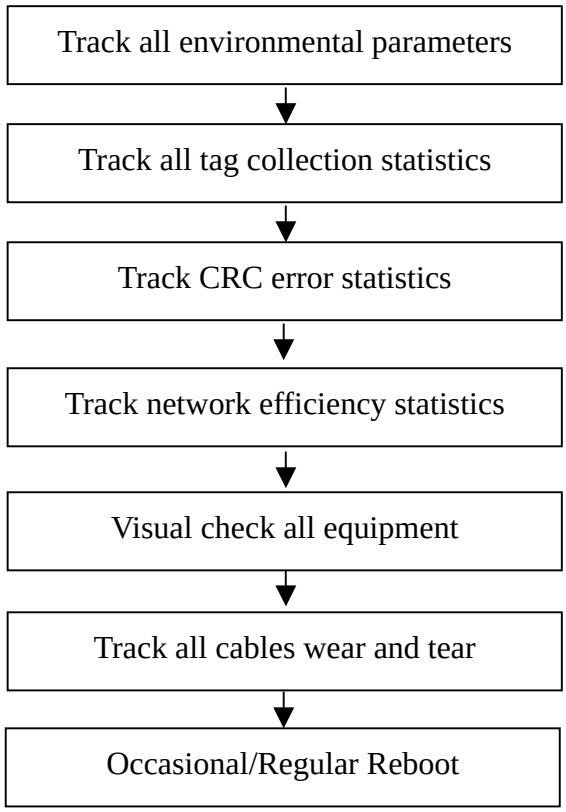
Test and commissioning is an important step to allow customer to verify the performance achieved, and formally approve the system to enter operational status. The most important part of test and commissioning is of course a mutually agreed test plan and commissioning criteria.

The experienced system integrator can probably propose this test and commissioning plan early in the project. This is particularly valid if the system integrator has done similar jobs before. However, sometimes a T&C document too early in the way will make it very difficult to accommodate for surprisingly low performances due to some uncontrollable environmental or business process related factors. So really it is at the system integrator's own discretion and wisdom when it should best be proposed.



8.2.12 Maintenance & Statistics

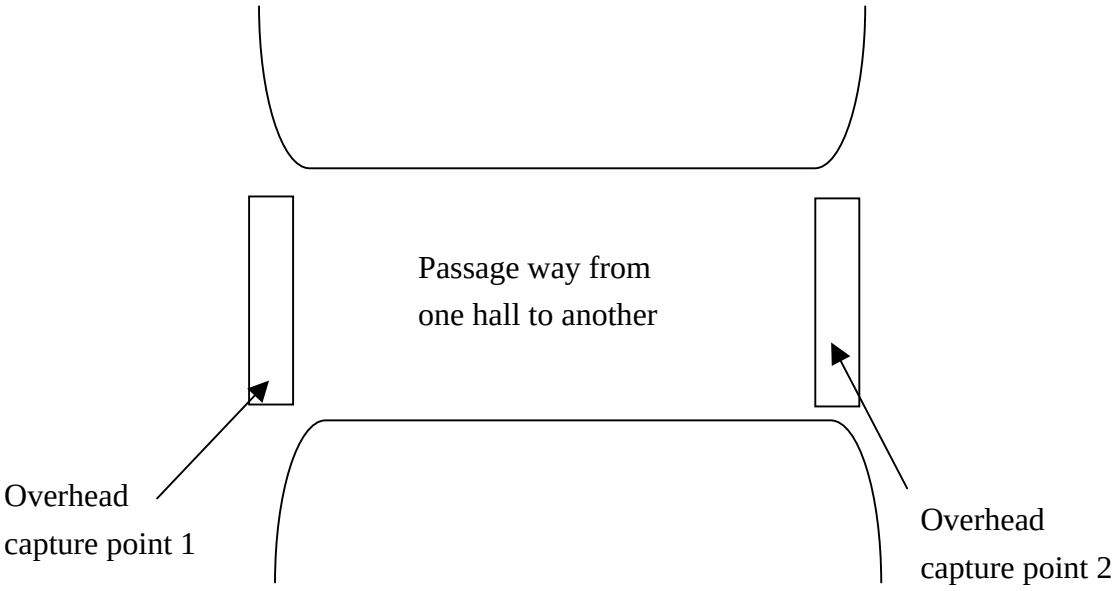
Maintenance of the RFID system is important. It includes preventive maintenance, collection and analysis of statistics of operation, etc.



8.3 Examples of Applications

8.3.1 Example: Access Control – Direction-Tracking

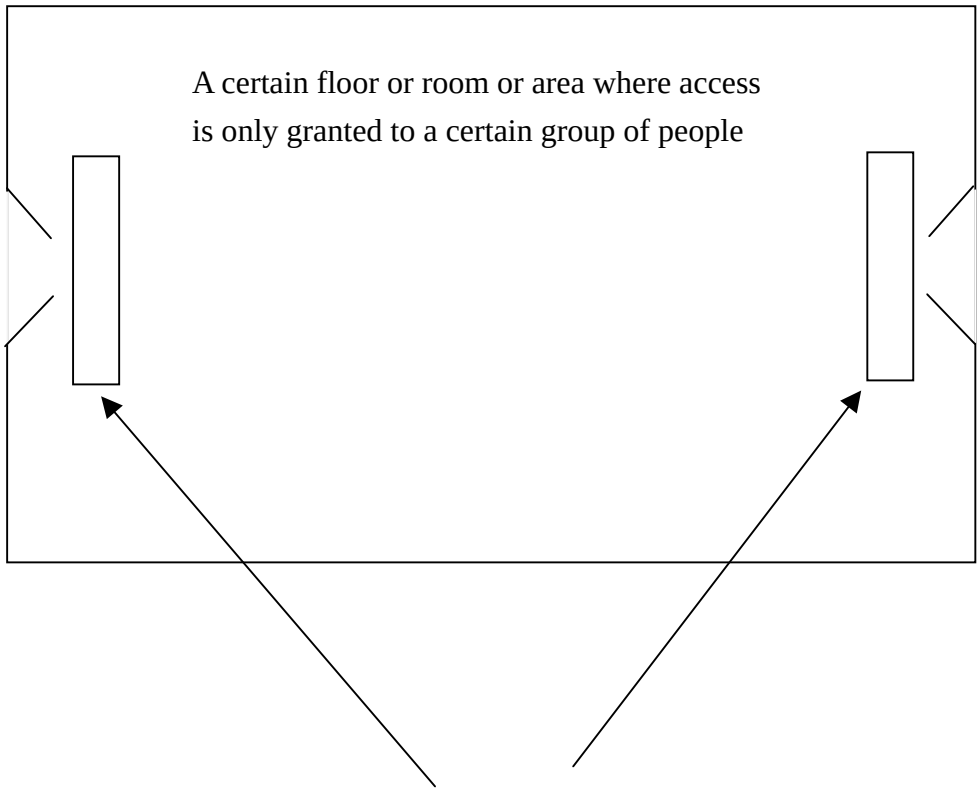
In certain access control applications, the end user may want to differentiate between a person entering a premise from leaving a premise. One way to do that is to have two RFID read operations (i.e. 2 capture points), one on one end of the passageway and the other on the other end. That way the direction of the person can be determined if one capture point reads the tag first and the second capture points reads the tag (the same tag) later.



8.3.2 Example: Access Control – Zonal

Monitoring

Zonal monitoring, control and denial are common requirements in business offices, factories, and institutions where either information security is required, or deliberate team isolation is needed.



Overhead capture points with zonal control, connected to PIR motion sensor and buzzer alarm as well as red light alarm.

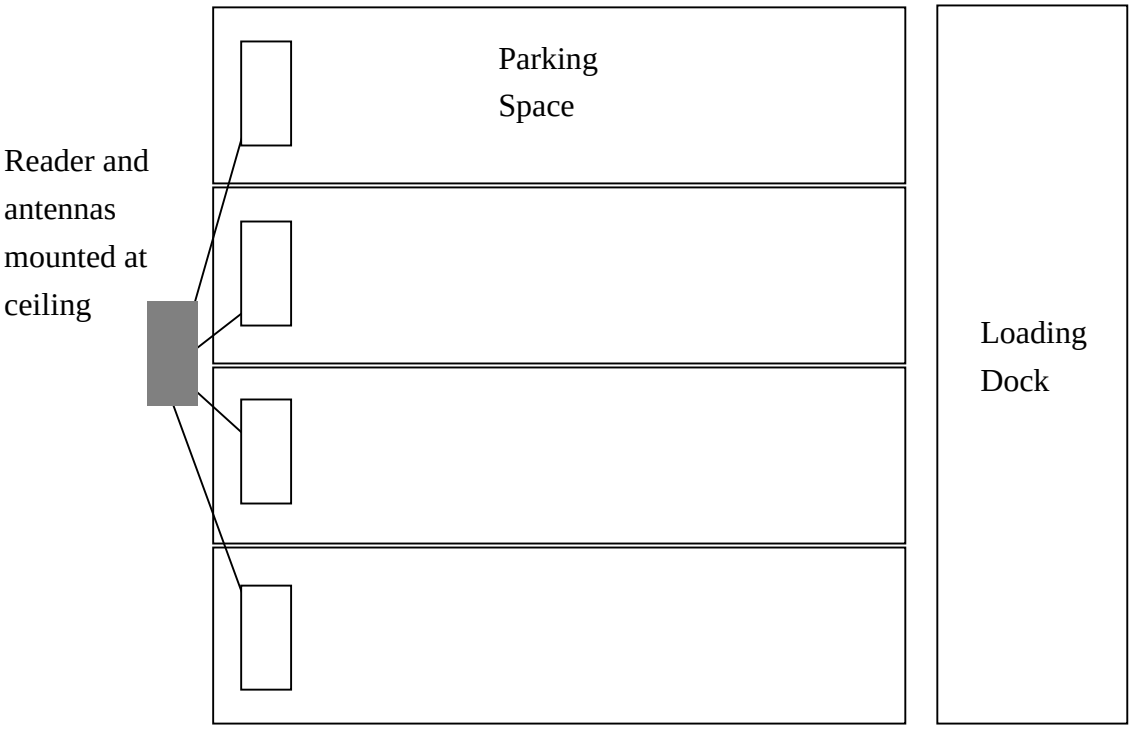
8.3.3 Example: Access Control – Salary Calculation

Access control contains time information that can be used to calculate salary. The tag group properties of the edge middleware allows one to easily program in the hourly rate, set the special rate ratio for overtime, weekend time and public holiday time. Once these are set, the worker's salary can be readily calculated.

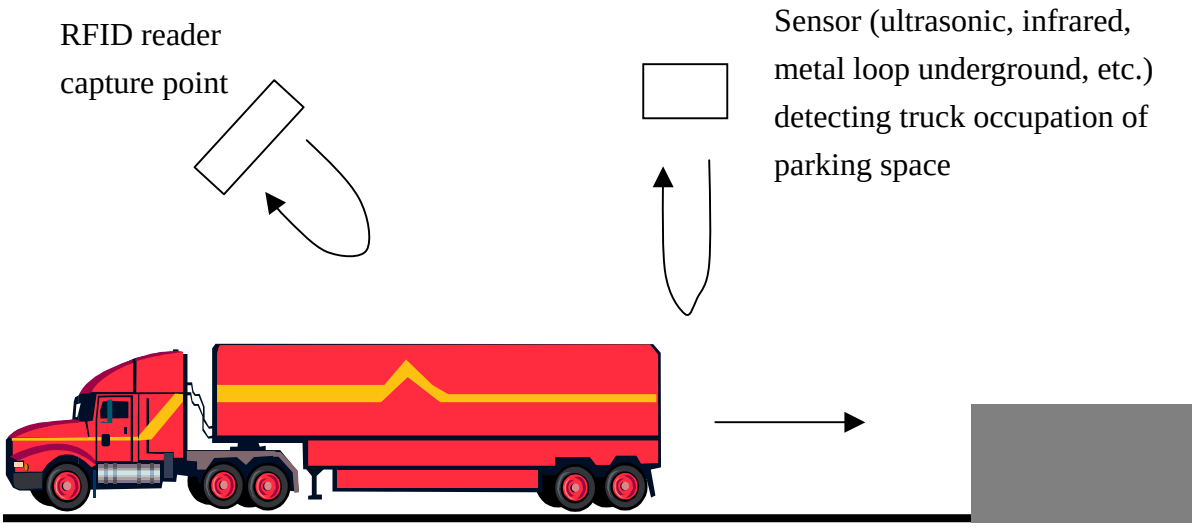
8.3.4 Example: Yard Management

Yard management controls in real time the allocation of parking space for trucks to unload and load products. An empty truck to be loaded with products must park onto the exactly correct parking space because a good yard management system will have workers already moved products to be loaded to that exact parking space just before the truck arrives. (A good example is the airport terminal operation, where each time the plane reaches a gate you always see a team of people waiting there). Likewise a truck to have products unloaded will have workers with necessary equipment waiting to unload products just before the truck arrives.

To ensure this, the RFID reader must read the truck tagged with RFID (usually a sticker tag on the inside of the windshield) just before that truck enters the exact packing space, and make sure that is the right truck. To do that, a sensor fusion action is needed: the RFID tag must be read, and that sensory information must come right before that parking space is detected to go from an unoccupied state to an occupied state.



The sensors that can achieve this kind of sensing include infrared sensor, ultra-sonic sensor, or magnetic loop. The reader first read the tag on the windshield as the truck moves into the space. As the truck occupies more and more of the space, it passes through a point where the sensor detects it. These two events occur closely in time and are together treated as a single event, signaling the truck of that particular ID has occupied the space.



Truck is backing up
into packing space

The incoming truck sensing sequence is as follows:

1. RFID reader capture point reads tag on windshield as the truck backs up. This read will continue for may be 2 seconds until the range of the tag becomes too large for the reader to read. The actual time depends on the speed of the backing truck.

2. Sensor (ultrasonic, infrared, etc.) will detect a reduction in distance of reflection, typically 2 to 5 seconds later, depending on the speed of the backing truck.

3. The time sequenced combination of the above two events will then signify that the truck with that particular ID has occupied that parking space.

The outgoing truck sensing sequence is as follows:

1. Sensor (ultrasonic, infrared, etc.) will detect an increase in distance of reflection back to the originally calibrated floor range, typically 2 to 5 seconds later, depending on the speed of the outgoing truck.

2. RFID reader capture point reads tag on windshield as the truck moves out. This read will continue for may be 2 seconds until the range of the tag becomes too large for the reader to read. The actual time depends on the speed of the outgoing truck.

3. The time sequenced combination of the above two events will then signify that the truck with that particular ID has vacated that parking space.

The following page shows the event definition that enables the above:

8.3.5 Example: Distribution Center

Within a distribution center, there are many important nodes that require RFID reading. Typical nodes include:

1. Dock Doors (incoming and outgoing)
2. Conveyor Belt Branch Points
3. Fork Lift Cars
4. ULD or trolleys

First of all, in the entrance dock door, the pallet, or even the case (box) within a pallet, needs to be read. To do that, the reader needs to have all four ports connected to antennas (total of four). These four antennas are placed on each side of the dock door, two on each side, one on top of the other (vertically stacked) on each side. The purpose of a vertically stacked array of read points is so that the boxes from a taller pallet can be tracked. The purpose of having antennas on each side of the dock door is so that the pallet can be read from both sides, so that for those tags that may be blocked from one side may actually be visible from antennas on the other side. Alternatively, one can have two antennas above the pallet and two pallets on the sides. In this case, the two antennas on the side should be rather low to ensure the low level boxes can be read.

For pallet level tagging, the pallet tag is usually a long narrow tag that can be nail affixed on any of the rim on the wooden pallet base. For case level tagging, each box (case) is affixed with a sticky type (slap and ship) tag. This tag can be placed on the outside or even the inside.

8.3.6 Example: Production Control

In production control, RFID can be used to help track the completion of the various steps of manufacturing process of the product along the way of the production line conveyor belt. It can also help identify to the workers the specific parts that need to be added in case of very complicated and high mix manufacturing environment. Furthermore, for products that need to go through a lengthy production period, e.g. more than 1 week, RFID tagging gives important real time status information and gives factory operator and sales department early warning of possible delays. With advanced supply chain management system, even the end customer can get a glimpse into the progress of the manufacturing. RFID also enables easy search and location of product, which is particularly important in applications where a lot of finished goods or semi-finished goods may be piled up such that those on the bottom of the pile cannot be easily visually identified.

8.3.7 Example: Retail Shop Combo

The most famous example is the Prada Epicenter shop in SoHo, New York. Although that is a very early experiment on use of RFID in retail shop, it does show how RFID can be used:

1. The tag is a paper tag that hangs on each piece of clothing (just like any other price label). When the clothing is taken into the dressing room for try out, the reader (or, capture point) inside the dressing room will read the tag and play back a section of video that shows a model wearing that dress doing a catwalk. This involves the video playback function of the reader.

2. The point-of-sales counter contains a short to medium range capture point that would read the tag on each piece of clothing. This will dramatically speeds up the payment process. The data is automatically submitted to the POS PC using the Instant Alarm alert mode of the event engine.

3. The retail shop door contains zonal reader hidden in the ceiling or placed on each side that reads whatever tag that passes through. If it does not belong to the “Paid” filter group, then the “Instant Alarm” alert mode will send alert and cause a buzzer to sing aloud.

4. A beautiful kiosk allows the customer with loyalty card to register and study what is the daily or weekly special discount item specially tailored for him or her (personalized discount item). Note that since this also requires a video display, it cannot be used simultaneously as that in the dressing room.

8.3.8 Example: Retail Shop Inventory & Fulfillment

The most famous retail shop inventory and fulfillment implementation is the Marks & Spencer example. Every night after shop closes, the worker uses a handheld reader to capture all the tags (i.e. all the clothes) hung around the shop, or placed inside the storeroom at the back. The total data is then immediately transmitted to a fulfillment center and the sold or missing sizes and colors are prepared throughout the night in the fulfillment center and shipped to the shop before 8 o'clock in the morning so that when the shop opens in the morning, all the sizes and colors are filled up again.

On the handheld reader, set the access point SSID and gateway IP address and make sure it is associated with the access point, which in turn is connected via the gateway to the external Internet. Key in the fulfillment center fixed IP and the link is now set up for automatic upload of tags read to the fulfillment center.

9 Regulatory Information

9.1 Federal Communications Commission (FCC) Compliance

This equipment has been tested and found to comply with the limits for a class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna
- Increase the separation between the equipment and receiver
- Consult the dealer or an qualified radio/TV technician for assistance

FCC NOTICE: To comply with FCC part 15 rules in the United States, the system must be professionally installed to ensure compliance with the Part 15 certification. It is the responsibility of the operator and professional installer to ensure that only certified systems are deployed in the United States. The use of the system in any other combination (such as co-located antennas transmitting the same information) is expressly forbidden.

Note:
Changes or modifications not expressly approved by the party responsible for compliance could void the user’s authority to operate the equipment.

9.2 Maximum Permissible Exposure

9.2.1 Introduction

This section has been prepared on behalf of CSL FHSS RFID Device to show compliance with the RF exposure requirements as defined in FCC §1.1307.

9.2.2 Requirements

Three different categories of transmitters are defined by the FCC in OET Bulletin 65. These categories are fixed installation, mobile, and portable and are defined as follows:

- **Fixed Installations**: fixed location means that the device, including its antenna, is physically secured at a permanent location and is not able to be easily moved to another location. Additionally, distance to humans from the antenna is maintained to at least 2 meters.
- **Mobile Devices**: a mobile device is defined as a transmitting device designed to be used in other than fixed locations and to be generally used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitter's radiating structures and the body of the user or nearby persons. Transmitters designed to be used by consumers or workers that can be easily re-located, such as a wireless modem operating in a laptop computer, are considered mobile devices if they meet the 20 centimeter separation requirement. The FCC rules for evaluating mobile devices for RF compliance are found in 47 CFR §2.1091.
- **Portable Devices**: a portable device is defined as a transmitting device designed to be used so that the radiating structure(s) of the device is/are within 20 centimeters of the body of the user. Portable device requirements are found in Section 2.1093 of the FCC's Rules (47 CFR§2.1093).

This CSL RFID device with 5.5dBi antenna is considered a fixed installation as it is used for the purpose of reading tags.

The FCC also categorizes the use of the device as based upon the user's awareness and ability to exercise control over his or her exposure. The two categories defined are Occupational/ Controlled Exposure and General Population/Uncontrolled Exposure. These two categories are defined as follows:

- Occupational/Controlled Exposure: In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. This exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means. Awareness of the potential for RF exposure in a workplace or similar environment can be provided through specific training as part of a RF safety program. If appropriate, warning signs and labels can also be used to establish such awareness by providing prominent information on the risk of potential exposure and instructions on methods to minimize such exposure risks.
- General Population/Uncontrolled Exposure: The general population / uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity. Warning labels placed on low-power consumer devices such as cellular telephones are not considered sufficient to allow the device to be considered under the occupational/controlled category, and the general population/uncontrolled exposure limits apply to these devices.

9.2.3 Radio Frequency Radiation Exposure Evaluation

The highest RF output power of the unit was measured at 29.8dBm at 915 MHz. According to §1.1310 of the FCC rules, the power density limit for General Population/Uncontrolled Exposure at 915 MHz is $f_{(MHz)}/1500 = 0.610mW/cm^2$. The MPE is calculated to show the required separation distance that must be maintained during installation to maintain compliance with the power density limit. The minimum required cable length is 1.5m to be used with this device.

The following formula was used to calculate the Power Density:

$$S = \frac{PG}{4\pi R^2}$$

Where:

S = Power Density

P = Power input to the external antenna (Output power from the EUT antenna port$_{(dBm)}$ – cable loss $_{(dB)}$)

G = Gain of Transmit Antenna (linear gain)

R = Distance from Transmitting Antenna

The power density at 20cm separation is:

$$S = \frac{PG}{4\pi R^2}$$

For this device, the calculation is as follows:

P = 29.8dBm (Output power from the EUT antenna port) – 0.75dB (cable loss*)

= 29.05dBm (= 803.526mW)

*Cable loss = (0.75dB) : 1.5m long of 0.5dB/m loss

G = Worst Case Antenna Gain = 5.5dBi = anti-log(5.5/10) = 3.55

At 20cm separation,

S = ((803.526) x (3.55)) / ($4\pi (20)^2$) = $0.568mW/cm^2$

Based on the above calculation for 20cm separation, the power density does not exceed FCC limit of $0.610mW/cm^2$.

10 Support

Technical support can be obtained from Convergence Systems Limited directly.

Please email to: support@convergence.com.hk

